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**DIGITAL GOVERNMENT SYSTEMS: TACKLING THE
LEGACY PROBLEM THROUGH A GAME-BASED
APPROACH TO BUSINESS REQUIREMENTS ANALYSIS**

Assia E. Alexandrova

A dissertation submitted for the degree of

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Abstract

Government agency reliance on legacy systems is problematic: they are costly to maintain, difficult to integrate with and they hinder innovation. However, the replacement of legacy systems is not a straightforward endeavor, and it often results in technology substitution that is not accompanied by business process change. The focus of this dissertation is on the phenomenon of legacy system replication wherein the requirements for applications replacing outdated technologies mimic legacy features and reflect status quo operational processes that have been historically shaped by the legacy system itself. This problem is referred to throughout the dissertation as the “legacy problem.” The dissertation investigates its roots and proposes an approach to overcome it. Specifically, a mixed method research approach is taken, including a survey of public sector practitioners to explore the extent of the legacy problem, and a series of semi-structured interviews with government information technology and management professionals to delve into the dynamics of legacy system replacement projects. Findings indicate that the legacy problem often stems from a lack of critical analysis of business requirements and the desire to minimize the risks associated with organizational change, which often result in missed opportunities for digital government innovation. As a consequence, the dissertation proposes a candidate approach to deal with the legacy problem in the development of a requirements game (RE-PROVO) which supports requirements discussions structured around the

themes of legacy (or heritage) preservation and innovation. The game is evaluated by local government practitioners through several iterations and their feedback is analysed to gauge the potential utility of the approach. The results indicate that with a streamlined user interface and accentuated game elements RE-PROVO can be a valuable and effective tool for requirements analysis in legacy system replacement projects.

Related Publications

Some of the research presented in this dissertation has been published or presented in the following outlets:

Alexandrova, A., Rapanotti, L. and Meehan, A.S. (2011) Requirements Practices in E-Government Solution Development. In *World Congress in Computer Science, Computer Engineering, and Applied Computing, 2011*. <http://worldcomp-proceedings.com/proc/p2011/EEE3707.pdf>

Alexandrova, A. (2012) Business requirements analysis and development for legacy system replacement projects in government organizations. In *Requirements Engineering Conference (RE), 2012 20th IEEE International* (pp. 337-340). IEEE.

Alexandrova, A., Rapanotti, L. and Horrocks, I. (2014) Innovation vs. Heritage: a Requirements Game to Encourage Creativity in Government Agencies' Legacy Systems Replacement Projects. In *REFSQ Workshops* (pp. 12-20).

Alexandrova, A., Rapanotti, L. and Horrocks, I. (2015) The legacy problem in government agencies: an exploratory study. In *Proceedings of the 16th Annual International Conference on Digital Government Research* (pp. 150-159). ACM.

Alexandrova, A., Rapanotti, L. and Horrocks, I. (2016) RE-PROVO: An Evaluation of Gamification in a Law Enforcement Organization. In *CEUR Workshop Proceedings - Proceedings of the Workshop on Fictional Game*

Elements 2016, SIGCHI Annual Symposium on Computer-Human
Interaction in Play (CHI PLAY 2016), Volume 1715.

List of Abbreviations

BCL Broward County Library

COTS Commercial Off-The-Shelf

DA Devil's Advocate

ILS Integrated Library System

IT Information Technology

PBL Points, Badges, Leaderboards

PD Police Department

RE Requirements Engineering

RFP Request for Proposals

SDLC Systems Development Life Cycle

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Chapter 1: Introduction

Digital government (also referred to its earlier moniker “e-government”) has gained increasing prominence over the past decades, as a result of the growing importance of information systems solutions for improvements in the efficiency of public institutions, the enablement of increased civic engagement, and generally of communal quality of life. The route to successful government information technology (IT) implementations, however, is challenging and complex, and a very high percentage of digital government efforts have been reported to fail – that is to fall short of achieving their objectives, both in regards to project-centric concerns, such as timelines, cost containment, and scope control, but also in terms of positive effects, levels of adoption and usage, constituent satisfaction, etc. (Heeks, 2003; Janssen et al., 2013; National Audit Office, 2013).

Some studies trace the causes of government IT project failure to factors such as lack of executive support, insufficient staff IT skills, mismatch between the solution and its context of use, and lack of stakeholder involvement (Gulliksen & Eriksson, 2006; Anthopoulos et al., 2016). As IT projects in many other sectors are affected by similar problems (Crotty & Horrocks, 2016), it is often unclear whether it is the context of public

organizations or the IT domain in a general sense that is the source of these issues, or perhaps a combination of the two (Scholl et al., 2010). Some factors, however, are more specific to government and rooted in an acknowledged aversion to business process change in government organizations (Hossan et al., 2011; Irani & Ellman, 2008), concomitant to an inability to conduct positive change at an acceptable pace due to political, cultural and technical barriers and constraints (Lam, 2005).

An oft-cited technical barrier is the lack of flexibility in legacy systems used by government agencies and their failure to integrate easily with new technologies. Upon further analysis (Lloyd et al., 1999), however, the purely technical nature of the legacy obstacle is debunked, and older IT systems are revealed as embedding legacy business processes and disguising aged and inadequate business rules and workflows as technical constraints. There are a number of reasons why sustaining legacy processes and systems is problematic. These range from overall organizational inefficiency to maintenance costs, but also very importantly legacy systems are not well-equipped to meet new demands for real-time citizen services, process transparency and performance management requirements (Halachmi, 2001). When combined legacy issues and constraints related to change-averse attitudes result in missed opportunities for innovations that can improve the quality of digital

government services delivered to constituents.

It has been observed that practitioners tend to err on the side of caution and take a conservative approach when considering changes to existing applications used by the public, or the introduction of new features and online services (Kraemer & King, 2005). As a result legacy constraints often make their way into the list of requirements for bespoke application development or software customizations (Hansen & Lyytinen, 2010). This is aggravated by the system development and project management methodologies prevalent in government, such as those prescribed by the Project Management Body of Knowledge (PMI, 2013) and Prince2 (ILX Group, 2017), which are by and large rigid and mechanistic (Sarantis et al., 2009).

The focus of this dissertation is to investigate ways of tackling legacy replacement and replication issues during the digital government solutions development process, with a particular emphasis on the business requirements analysis phase of the life cycle.

Requirements analysis has been characterized by Aurum & Wohlin (2003) as an analytical medium which promotes both organization-oriented macro decisions and process-oriented micro decisions by virtue of its decoupling of technical from business considerations in the early phases of systems development. In fact, requirements analysis has been recognized by these authors as a decision-making and problem-solving activity, where opportunities must be sought for practitioners to be more engaged and more creative, something of particular value in legacy systems replacement.

Landmark requirements engineering paradigms such as goal-oriented requirements analysis (van Lamsweerde, 2001), problem-oriented approaches (Jackson, 2001; Hall et al, 2007) and perspectives-based requirements engineering (Shull et al, 2000) could be of great utility in legacy replacement projects by focusing on the definition of high-level enterprise business problems and on particular aspects of organizational change which could promote innovation and deeper inquiry into the rationale of existing business processes. These paradigms and the methods based on them - KAOS, or i* as examples (Maiden, 2005), can assist in defining goals and concerns that explicitly address legacy feature replication and identify specific requirements which unnecessarily reproduce elements of a legacy model. However, the learning curve associated with understanding their theoretical foundations, and the

mastery of their execution is substantial (Marcelino-Jesus et al, 2016). As the analysis presented further in this thesis will reveal, the uptake of more formal requirements practices in government agencies is reportedly low, and digital government practitioners in particular are not systematically employing those requirements methods which might assist them and bring rigor when addressing the legacy problem. This is why this dissertation explores a more lightweight approach combining requirements analysis with gamification to promote practitioner requirements activity focus and stakeholder exploration of systems and process innovation.

1.1. Distinguishing Characteristics of Digital Government and Justification of the Research

Digital government's distinctness stems not only from the bureaucratic and legislative aspects which define and constrain digital government solutions, but from a number of other qualitative factors, briefly discussed in this section.

Some factors concern the "what"-s of public information solution production, namely the kinds of applications and features introduced for use by the public, or internally within public organizations themselves.

Such applications cover mainly the processes which lead to the issuance of “status documents” such as licenses, permits, certificates, registrations and the like, and constituent requests for the provision of services (e.g., infrastructure repairs, social assistance, logistical services, education, and others). Charalabidis et al. (2006) develop a taxonomy of municipal e-services which exemplify the standard set of digital/e-government applications. One of their characteristics is that they are based on political and legislative requirements that may date a couple of decades back, and more relevant to our inquiry, they are typically maintained by some form of legacy system. The historical nature of government systems (and processes) is a key characteristic of digital government, as are the issues of legacy and compatibility both in the sense of IT and in regards to business process.

Other factors of differentiation concern the “why”-s, or the motivations and objectives driving digital government projects. Difficult to quantify goals such as satisfaction, trust in government, ease of use, sense of security and wellbeing, etc., are often the impetus for creating and introducing systems (Mayer-Schönberger & Lazer, 2007). This implies a different feature selection and prioritization process, one which reflects more closely the “checks and balances” principles in the public sector. This process logically belongs to the requirements analysis and development aspect of a software project. Political considerations can influence selection

and prioritization in government IT (Sarantis et al., 2010), where political is defined as ideological, i.e., representative of different societal and social views and interests, rather than as expressive of the agendas of units internal to the organization. Dealing with such influence in a systematic, overt and equal manner is a value shared by both the democratic principles driving public governance and by the tenets of requirements engineering methods. Therefore, the methodical implementation of appropriate techniques from the requirements engineering discipline has the potential to contribute to ethical, principled and accountable government operations. In fact, digital/e-government in itself, as an activity that brings transparency to process, has been characterized as an anti-corruption strategy (Andersen, 2009).

The procedural aspects, or the “how”-s of systems definition, development and realization, also make digital government solutions distinctive. Government IT is highly procurement-driven, hence it is affected heavily by bureaucratic procedural barriers. A significant number of Commercial Off-the-Shelf (COTS) products dominate the IT portfolio of public agencies, leading frequently to silos of system families and “shops” within IT departments (Peristeras & Tarabanis, 2000). In the case of bespoke development, government application teams generally operate within slow

development cycles, impacted by project scope creep (Sarkar, 2010), by project decisions often dictated by a spirit of aversion to risk (Margetts, 2005), and by a reactive stance towards public officials and executives, whose project leadership is either missing (Edmiston, 2003), or inconsistent, resulting in abrupt changes to the course of a project (Boyne, 2002).

In addition to the exercise of influence from governing bodies and elected officials, digital government applications must represent the interests and preferences of a multitude of stakeholders and constituents. It is in the area of collective social impact of information systems, where one of the more salient distinctions of government IT solutions development from commercial technology becomes apparent – namely the notion of “public value” (Moore, 1995), which refers to the achievement of certain holistic benefits for society, benefits which are different than the mere sum of individual (consumer) preferences of society’s members. If applied to the information solutions digital government must produce, public value can be achieved only with a holistic view that integrates the systems themselves, the social context of their use, and the organizational context of their development and management. The information-rich medium of requirements elicitation, analysis and development activities has the highest potential for the integration of these perspectives – by means of a thorough assessment of stakeholder needs, improved problem definition,

solution feature negotiation and consensus-building – all key determinants of information solution project success (Hoffman & Lehner, 2001).

The government projects of interest for this research are therefore those that enable the provision of direct services to constituents whether those are created through bespoke development or through customization of COTS software products. More specifically, it is such applications deployed by local government agencies that constitute a special case where the effect of legacy systems models and potentially outdated business processes on new digital government services can be experienced tangibly. Local governments are responsible for public services, such as neighborhood improvement, transportation, public safety and other local services that affect the public directly. Unlike federal government operations that have a national scope (e.g., the Federal Trade Commission in the United States) or longer-term effects (environmental protection agencies), or administrations that have a regulatory and monitoring capacity, local agencies' activities have more specific, geographically-bound constituencies, who generally have a better understanding of local government's role, interact with its officials regularly and can evaluate their efficiency first-hand.

1.2. Research Aim and Objectives

The aim of this dissertation is to study the dynamics of business requirements analysis in government legacy replacement projects specifically, and to propose a game-based approach for analysis of business risks and opportunities in the requirements engineering process for these projects. The choice of gaming and gamification is motivated by their increasing adoption and success in education, skills training, and community-building (Kapp, 2012), as well as by business applications where gamified strategies have shown promise in ensuring greater motivation (Werbach & Hunter, 2012), innovative thinking and creativity (West, 2014).

In order to fulfill this aim, the following research objectives have been established:

a) To characterize the current state of requirements engineering practices in digital government projects which involve legacy system replacement, i.e., what type of activities are widespread and which of them are considered particularly useful.

Empirical study of the specific area of legacy replacement projects in local government agencies will offer insight on the requirements practices utilized and on the unique challenges faced by those practitioners dealing with requirements analysis -- including both COTS system features

customization and bespoke development in cases where existing legacy functionality and business processes must be built upon, and fill any potential gaps in both academic and industry research on the use of requirements engineering methods (or the lack thereof) in the public sector in general.

b) To establish the extent and manner in which legacy systems and business processes are reproduced in new solutions and applications.

The empirical inquiry undertaken to fulfill this objective (Chapter 3) provides a detailed examination of the ways in which government organizations frame the legacy problem, and the conditions under which it is either promoted or successfully overcome. Its contribution is a better understanding of existing models of innovation in the context of local government organizations.

c) To assess the attitudes expressed by digital government practitioners during the planning stages of legacy replacement projects – whether aversion to risk or propensity to innovate, or other approaches to change, and how they manifest themselves at the requirements level.

Practitioners tend to avoid introducing changes to current business processes, as the success of digital government projects becomes subject to risk. However, risk is inherently present in every new system implementation, as is opportunity for business improvement. Determining how practitioners' attitudes impact project risk analysis, and consequently functional requirements determination, contributes to an enhanced understanding of digital government success factors.

d) To develop and evaluate the utility of a game enabling the structured discussion of requirements along the themes of risk aversion (legacy preservation) and innovation, and to foster creativity in business (functional) requirements analysis during legacy system replacement projects.

Game-based approaches have mostly been applied for educational/instructional purposes. Games have not been evaluated sufficiently so far for their potential to inform operational decision-making neither in the requirements engineering field nor for other types of problem-solving and collaboration in local government agencies. Introducing a game in this context constitutes an innovative model which could have implications for the design of tools that support creativity, innovation and collaboration in digital government projects.

1.3. Research Methodology

The research problem explored is multi-faceted: the dynamics of requirements processes and digital government projects are affected by multiple organizational-level, individual-level or technical factors. Its organisational scope is primarily local government agencies at the city, county, municipality, borough, metropolitan district, and equivalent levels. This was deemed an appropriate scope due to the involvement of local government agencies in tangible projects where front-line communication and interaction with constituents is involved. Its system scope includes online applications where local residents are ultimately affected by the implementation of the system, whether they are direct users of it, or whether it is mostly operated by agency staff.

The research aim and objectives call both for an analysis of the legacy problem during legacy systems replacement in local government agencies, and for the development of a game to be evaluated by practitioners in a real-world setting. For the former, a mixed-method research approach, defined as the combination of quantitative and qualitative approaches, is necessitated by the complexity of the problem under investigation (Creswell, 2008) and by the need to capture the richness of the practices that are being studied. These take the form of literature review, surveys

and interviews. For the latter, we will apply what is referred to by Oates (2006) as "design and creation research" or the offering of a working system that instantiates models, constructs, or methods, as a contribution to knowledge. This type of research corresponds to what Nunamaker et al. (1990) classify as formulative and developmental research. Formulative research is distinct from verificational research in that it deals with the identification of problems for further investigation and scoping, rather than with collecting evidence to support or rule out already formulated hypotheses. Developmental research involves the creation of an artefact used to test underlying concepts or models – in this case the gamification of a requirements argumentation and deliberation model. In order to establish key requirements for the game design, surveys and interviews will be utilized as data collection methods.

The research methods corresponding to each research objective are summarised in Table 1.

Table 1. Research Objectives and Methods

Objective	Research Method
a) To characterise the current state of requirements engineering practices in digital government projects which involve legacy system replacement – i.e. what type of activities are widespread, and which of them are considered	Literature Review Online Survey

particularly useful.	
b) To establish the extent to and manner in which legacy systems and business processes are reproduced in new solutions and applications	Literature Review Qualitative interviews Online survey
c) To assess the types of attitudes expressed by digital government practitioners during the planning stages of legacy replacement projects – whether aversion to risk, or propensity to innovate, or other approaches to change, and how they manifest themselves at the requirements level.	Literature Review Qualitative interviews
d) To develop and evaluate the utility of a game to enable a structured discussion of requirements along the themes of risk aversion (legacy preservation) and innovation, fostering creativity in business (functional) requirements analysis and development during legacy system replacement projects.	Game Prototype Development Follow-up Qualitative Interviews Textual analysis Quantitative game metrics analysis

1.3.1. Literature Review

An in-depth review of academic and industry literature in the fields of requirements engineering, software development, and digital government

was conducted to examine how legacy systems replacement is conceptualized and implemented in government organizations (objective (c)). It sought out evidence of the existence and prevalence of the legacy problem (objective (b)), and surveyed the techniques and approaches employed in legacy replacement projects, probing deeper into those that can potentially disentangle “historical” features of systems from essential and current business needs (objective (a)). An exploration of the application of serious games and gamification to encourage creativity in requirements activities was also conducted as part of the review, to support the delivery of objective (d).

1.3.2. Survey Instrument

A survey was developed to fulfill objectives (a) and (b). The purpose of the survey in the context of objective (a) was to provide a "bird's eye view" of requirements activities undertaken for legacy system replacement projects in the context of government agencies and to determine who are the organizational actors responsible for requirements-related activities in these projects. In the case of objective (b), the survey was used to address the quantitative aspects of the legacy problem, namely the extent to which legacy systems functionality is replicated in replacement applications. Survey research was selected to address these objectives because it is suitable for obtaining data from large groups of people and arriving at generalisable conclusions and patterns (Oates,2006). As part of the survey,

respondents were asked whether they were interested in taking part in one-on-one in-depth interviews, as this was considered a viable way to attract participation for the next research step.

1.3.3. Practitioner Interviews

To satisfy objectives (b) and (c), digital government practitioners primarily from local government organizations were interviewed using semi-structured interviews: the topics were established in advance, but their order could be changed, and interviewees were able to offer information that was not preliminarily defined in the questionnaire. Interviews are an appropriate method of research in cases where the questions asked are complex or open-ended, and where experiences and feelings are the subject of exploration (Oates, 2006). Also, qualitative interviews are a fitting method to generate rich, in-depth data as the descriptions of the practices studied are in practitioners' own words and definitions. The literature review highlighted risk aversion as an attitude that stems from cognitive dissonance, fear of failure or shaming, and similar negative repercussions. One-on-one interviews were hence considered a more inviting means to talk about more sensitive topics such as project failures, individual attitudes and sentiments.

The qualitative interviews were conducted after analysis of the quantitative survey results, following an explanatory sequential strategy (Creswell, 2008). This allowed for data collection gaps and ambiguity encountered during the quantitative survey phase to be followed-up and remedied with in-depth interviews, and similarly for better interpretation of the quantitative findings by asking related questions in the interview phase.

1.3.4. Game Prototype Development

Objective (d) involves the development of a game and its evaluation. The creation of a software system/tool itself can constitute a research act, in that practical systems development can become interpretive research if the learning associated with this development is articulated as part of an appropriate conceptual framework (Hughes & Wood-Harper, 1999). The development process followed the principles of design and creation research, namely the iteration of five key steps: awareness (the recognition of a problem), suggestion (offering a candidate solution for addressing the problem), development (the design of a solution artefact), evaluation (assessment of the artefact worth) and conclusion (consolidation and critical analysis of the assessment results and identification of knowledge gained in the process) (Oates, 2006).

Triadic game design (Harteveld, 2011) was employed to inform the development of the game: it distinguishes between three main areas of design – the ludic, semiotic, and the ontological, or, alternatively phrased, play, meaning and reality respectively. Triadic game design is explained in detail in Chapter 5.

1.3.5. Game Evaluation

A small number of practitioners from different organizations were recruited to assist with functional and usability testing of the game, so that external feedback was incorporated during the game construction. After prototype completion, the game was made available online to teams of practitioners from two separate local government organizations with either ongoing or past legacy replacement projects. The assessment of the game's impact consisted of an analysis of game metrics obtained automatically during game play, and an analysis of feedback obtained through semi-structured follow-up interviews with participants.

1.4. Contribution to Knowledge and Impact on Practice

This research addresses an issue of substantial operational significance for

government agencies – the effective move away from legacy technology. In particular, the dissertation sheds some light on targeted requirements engineering approaches that address the unique characteristics and complexities of legacy embeddedness in government organizations, something that had not been reported in academic literature previously. It fills this gap by gathering empirical data about current requirements practices, and by developing and evaluating an innovative approach to requirements negotiation and argumentation based on game elements and gamification concepts.

Besides this theoretical contribution, the research has potential impact on practice by offering a tool that practitioners can directly apply to the analysis of requirements for the replacement of legacy systems in their agencies.

1.5. Structure of the Dissertation

The remainder of this dissertation is organised as follows. Chapter 2 features a review of relevant academic and industry literature on the topics of legacy systems, risk and innovation in government agencies, requirements engineering practices in the public sector, serious games and gamification. Chapters 3 to 5 discuss the primary research. Specifically,

Chapter 3 describes an online survey and practitioner interviews carried out to investigate the nature of the legacy problem in current practice, and reviews and discusses their findings. Chapter 4 outlines and justifies the initial design of the requirements game (named PROVO), presents the outcomes of its initial evaluation, and then describes the second version of the game (renamed to RE-PROVO) with details of the changes made to the game's elements and flow, Chapter 5 details the game's technology implementation, and reviews and analyzes two separate RE-PROVO evaluation sessions with local government practitioners from different organizations. Chapter 6 establishes the dissertation's conclusions and outlines directions for future research.

Chapter 2: Literature Review

This chapter will focus on the relevant academic and industry literature that has informed the conceptual investigation into the legacy problem, and guided the primary research into its manifestations and the potential approaches to its resolution.

Sections 2.1 - 2.4 examine the problem space of legacy system replacement endeavors in the public sector, while Sections 2.5 -2.7 the solution space. The chapter begins with an examination and a working definition of the legacy problem (Section 2.1) and then presents several socio-technical explanatory frameworks which are applied to interpret its dynamics (Section 2.2). The varied and complex sources of legacy replication issues are then examined (Section 2.3) through the lens of Rittel and Webber's (1973) wicked problems, as a class of problems which defy mechanistic, linear and purely technical approaches. The roots of the legacy problem's wickedness are found in the tensions that arise from the public sector's conflicting mandates, its proverbial risk aversion and its lack of mechanisms to assess risks concurrently with opportunities for innovation. Section 2.4 examines the potential benefits of adhering to requirements engineering methods in public sector legacy replacement projects, and delves into several different approaches to organizational change that are typically displayed during the requirements phase of these projects. In Section 2.5, some examples of early groupware tools that support

collaborative decision making and discussion are provided, followed by a review of creativity techniques employed in requirements activities (Section 2.6). An examination of serious games and their potential application as a creativity-inducing mechanism to aid in the tackling of wicked, tough or complex issues such as the legacy problem follows in Section 2.7. The chapter concludes with a critical summary in Section 2.8.

2.1. The Legacy Problem

Legacy technologies, such as mainframe systems or software applications developed using older platforms, have been recognized as an obstacle to information technology innovations in public agencies and to establishing more flexible, transparent and responsive government services (Ebbers & Van Dijk, 2007; Halachmi, 2011; Gong & Janssen, 2012). Legacy systems are also said to be barriers to strategic innovation (Kelly et al., 1999), because they are difficult to modify, almost incapable of accommodating changing business processes, unable to provide new functionality and features easily, and difficult to integrate with (Fisher & Bradford, 2005). Such characteristics are usually regarded as technical in nature, so there has been substantial research dedicated to technologies that help extend the life of legacy systems and make integration with them easier, such as “wrappers”, web services, screen-scraping technology etc. (Comella-

Dordaet al., 2000; Rahgozar & Oroumchian, 2003). Legacy technologies, however, pose more than technical challenges, in that due to their extensive usage (usually spanning decades) and scale, they have become ingrained in work processes and organizational culture, to the extent that they have come to define the *modus operandi* of public agencies. Kelly et al. (1999), citing Kim (1997), define legacy systems as an ‘accumulation of years of business rules, policies, expertise and knowhow.’ The capabilities and limitations of legacy technologies are essentially a source of design of workflows and procedures used in many organizations – Lloyd et al. (1999) provide multiple illustrations of how legacy applications “lock-in” inefficient processes.

While the problematics of new systems implementation and the changes it brings to business processes have been well-documented and researched as a general topic (Volkoff et al., 2007; Benders et al., 2006), the business/operations aspects of legacy systems replacement in public organizations specifically has received sparse attention. Furthermore, its unique dynamics have not been recognized outside of case studies that highlight mostly technical issues (Rouelle et al., 2011) or project management failures (Fukami & McCubbrey, 2011).

This thesis argues that the environment of bureaucratic and legislative rigidity in which public agencies operate (Boyne, 2002) and the legacy

technologies used in such agencies mutually reinforce each other in ways that make it hard to “disentangle” operational (or business) dimensions from technological (or software) functions and structures. Therefore, this thesis defines the “legacy problem” as the uncritical replication of legacy systems in the requirements for applications that supersede them. Such replication is intended to minimize the changes to business processes which were shaped by the technological constraints of those same legacy systems. Government organizations are typically unable or reluctant to move away from anachronistic work practices defined by and embedded in legacy IT systems because the rationale for them has not been made explicit. For instance, Lauder & Kent (2002) acknowledge “implicit business processes” as a legacy systems pattern, while Edwards and Millea (2002) cite embedded business knowledge as one for four typical legacy issues that plague organizations. Furthermore, the business processes and practices embedded in legacy technologies are often uncritically accepted and “legitimized,” and they become an important source of requirements for future software applications.

One of the most fundamental ways in which the legacy problem manifests itself is in creating a form of paralysis when organizations consider changes to business processes, this paralysis being further reinforced by

the promulgation of organizational rules that have often been developed as workarounds to limitations of the very same legacy systems (Robey et al., 2002). Expressions of this phenomenon occur most ostensibly when legacy systems reach the end of their technical life or the end of the contractual agreements with the vendors supporting them. Gupta and Bhatia (2005) suggest that this also occurs at times when there is major IT “upheaval” such as an ERP implementation. Meanwhile, Oliver (1992), while not discussing legacy systems directly, reveals that practices and policies fall out of favor at times of performance crises or when there is external pressure for reform. The organization then feels compelled by external factors to create, or procure, a faithful replica of the legacy system so that no disruption to the status-quo is introduced while the new system is compliant with the external demands for technological transformation. Furneaux and Wade (2011) explicitly examine the effect of “system embeddedness” on organizations’ intentions to discontinue usage of certain information systems. In their study, they postulate that there will be an unwillingness to abandon certain software usage if it is deeply entrenched in organizational routines.

A key characteristic of the legacy problem is that it makes anachronistic business practices opaque. A case study of the migration from the legacy Central Accounting System (CAS) in the State of New York (Fisher & Bradford, 2005; Fisher & Bradford, 2006) similarly asserts that the system

was preserved for decades because its reliability had lulled the State into complacency. As it is not immediately obvious that business processes bear the imprint of an outdated system, a pertinent question to this discussion, therefore, is how we can tell when legacy system embeddedness is pervasive in an organization. Some materializations of the legacy problem can be found in the replication of workflows which are outdated or unnecessarily elaborate, or the lack of business process documentation other than legacy code (Gupta & Bhatia, 2005; Kardasis & Loucopulos, 1998). Others relate to the redundant co-existence of electronic case files in several systems (Fisher & Bradford, 2005), or alongside physical case files either because mainframe applications did not have the ability to store additional information electronically (files, photos, etc.) or due to the data fields having character constraints (Adolph, 1996). Others still in the poor usability of web forms due to “front-ending” of mainframe screens, or the breaking up of information into sub-entities due to space and screen limitations (Adolph, 1996), which introduces “artificial” categories of information, etc. In other cases we witness the usage of legacy system terminology in communication with constituents, or in legislative documentation. Finally, in other examples “shadow” systems have emerged to deal with the gap in business needs practitioners experienced (Fisher & Bradford, 2005).

Even if a business workflow, application data structure or report format can be identified as a carrier of legacy elements, the more complicated task is to determine how they can be transformed to be more efficient. The analysis necessary to re-define a system and its associated business processes based on current needs or technology, or even better, based on a strategic, forward-thinking model, calls for a collaborative effort of a diverse group of stakeholders. To understand what factors can contribute to the success of such an effort, one must inquire into the roots, causes and organizational dynamics which result in the legacy problem.

2.2. Socio-technical Perspectives on the Legacy Problem

There have been different explanatory treatments of the conditions and circumstances that comprise the legacy problem, most of them complementary and not exclusive of one another. The most explicit framing of the dynamics described so far is offered by Homburg (2008) in his analysis of the national trajectories of digital government development. Homburg articulates the legacy problem in stating ‘until recently [...] specifically mainframe technologies tended to be applied in such a way that they replicated the formal structures that already existed in classical bureaucracies.’ He cites Nohria and Berkley (1994): ‘computer systems and software adopted the “architecture of bureaucracy”. Not surprisingly the language of information systems became the language of bureaucracy.’ This statement is not dissimilar to Conway’s Law, which, in an historical context

of bespoke greenfield software development, states that software tends to replicate the structure of the organization which created it (Conway, 1968). In adopting this perspective, transitioning from legacy systems is a critical step not just for technological modernization, but also in the sense of organizational, and even more of civic and political transformations, as this step absolutely impacts the bureaucratic architecture of government agencies. If organizations in the government sector are still rigidly hierarchical, with formalized decision-making processes, rather than flat, flexible, collaborative and cross-functional entities (Heintze & Bretschneider, 2000), it is foreseeable that they will gravitate towards preservation of the systems that fit their culture and structural composition.

Government bureaucracies could be likened to what Kelly et al. (1999, p. 6) define as a 'centralized structured collection of specialists who in most cases rely on a fixed set of standard operating procedures to deliver mass-produced product or service.' Consequently, a public agency's ability to deliver personalized, customized service to constituents could be adversely correlated to its reliance on legacy technology – a claim that requires further empirical investigation.

Insights from political science can be applied to support the formulation of the legacy problem. One such is Olson (1982)'s "ossification thesis" which stipulates that the proliferation and strengthening of interest groups (or "distributional coalitions") in a society makes it ossified and stifles its growth. Olson utilizes this concept to explain societal developments on a macro scale, although it can be applied to the analysis of government organizations and their internal dynamics as well. According to Rauch (1994): 'Economically speaking entrenched interest groups slow the adoption of new technology and ideas by clinging to the status quo,' which on a smaller scale also applies to legacy systems. Interest groups would therefore include the vendors of legacy software, consultants, the technical staff that supports it, the managers who rely on its output, and miscellaneous staff whose functions include supplementing the legacy system in some way, e.g., re-coding outputs, (re-)processing reports, manual data copying into other systems, etc. While these may not seem like coalitions with absolute powers, their expert input when considering systems replacements significantly impacts the specifications for new technologies and applications. For example, the only specialists who can interpret the legacy code and translate it in business terms are often the principal engineers of the system (Adolph, 1996). The "specialist knowledge" of the legacy interest groups also secures them powerful positioning in the organization due to their control over the data used in decision and policymaking (Horrocks, 2005).

The interest group argument can be further augmented with more individual-level psychology concepts. Jermias (2001) examines resistance to change through the prism of “cognitive dissonance,” defined as the simultaneous belief in two contradictory notions – in our case on the one hand of the positive aspects of a legacy system, and on the other of the realization that the system must be replaced. When information on the usefulness and potential benefits of new software, or a new way of doing things, comes into conflict with in-depth knowledge of a legacy system and its reliability, people will fall back on their commitment to their favored system or model and will tend to overstate the risks and drawbacks of the new system. Users, developers, administrators and managers will therefore, more often than not, advocate for the familiar and avoid the cognitive pressure to un-learn old applications and models.

Frequently, though, the issue is not one of unwillingness to adapt, but rather of difficulties with re-training and retooling of employees. Heygate & Spokes (1997) outline the communications and human resources issues that accompany legacy migration projects and emphasize the importance of accommodating all stakeholders, e.g. negotiating with unions, customizing outsourcing arrangements, etc.

Further support for the proposition that the legacy problem can be explained as the interplay of individual and structural, or organizational issues, can be found in van Duivenboden et al. (2008)'s investigation of innovation dynamics in public agencies. The authors argue that there are numerous environmental factors which stifle innovation and change in public administration and cause government operational managers and staff to generally refrain from straying from established processes and workflows. These include lack of freedom to experiment, general aversion to risk, a punitive reaction to making mistakes, and no meaningful rewards provided when challenges are overcome. So, even if public employees see the benefits of departure from a legacy system, they may not choose the route of change, or might approach it conservatively, if a positive outcome is not guaranteed and a potential failure could be exposed by the media or by critics as yet another example of government incompetence and waste.

The common denominator observed in most justifications for extending the operational models embedded in legacy systems is that change is just too risky. In fact, some organizations will make a substantial effort to prolong the life of a legacy system in various ways, with more radical changes entailing new systems implementation or development deemed too intimidating (Computer Economics Report, 2011). The risks associated with potential project or software failures and budget overruns during

legacy software replacement are assumed to outweigh the benefits of the new systems and/or business models being introduced. Risk is usually defined as the possibility of loss expressed probabilistically (Slovic et al., 2004), but often the risk discourse occurs in an ad-hoc manner (Evangelidis et al., 2002) and no systematic or objective analysis to assess the potential for losses is actually undertaken. In such instances the potential risks discussed by IT or business managers could be anecdotal, understated, overstated or mis-stated: what is communicated as risk, might be a general feeling of discomfort, or fear of change instead. Slovic et al. (2004) have discussed the affective load of the notion of risk and argued that it is actually the phenomenon of emotionally-guided impressions influencing decisions, or the so called “affective heuristic,” that constitutes the dominant form of risk assessment. Ryan (2016) confirms the prevalence of the affective heuristic, explaining that by default ‘humans possess a negativity bias’ in which the potential for a loss is considered worse than the prospect of winning. In organizational settings, this individual human propensity is manifested exponentially. In government organizations the negativity bias is embedded in the institution’s policies and rules and is hence exacerbated by bureaucracy. This translates to situations in which potentially valuable information systems initiatives are stifled because their novelty or magnitude conjures up images of unknown and negative outcomes. Instead, a preservation of the status-quo, or the

legacy, is preferred. While this may not seem necessarily problematic at first, upon closer review it emerges as a rather irrational approach. Continuing the reliance on legacy software and legacy business processes is not in and of itself an act of risk mitigation: the risks of continuing legacy utilization and the potential for benefits of any new system need to be factored into a risk analysis on par with the possible losses and costs associated with legacy replacement. In the words of Myddleton (2007), who examined large-scale government project failure, sustaining legacy systems contains high “opportunity costs,” or the costs of foregone benefits from other projects or systems which could have been implemented instead. The need for a balanced risk assessment in which all courses of action are evaluated concurrently is essential in the risk-averse government environment, where innovations in response to constituent demands are detrimentally slow-paced to begin with (Lazer, 2002). In the absence of a stable, data-rich reference model from which quantifiable, or at a minimum, confirmable outcomes can be forecast, only negative repercussions of an action are usually assumed, albeit in non-probabilistic terms. Yet, when business change results from the introduction of, or modifications to, an information system, there are not only risks involved, but also opportunities (or benefits) to create favorable circumstances for positive outcomes, and these need to be made explicit for the risk assessment to be fully informative and objective (Hilson, 2002).

Some implementation difficulties may emerge if government agencies are to attempt to supplement their risk assessments with an analytic review of opportunities, however, as it may be difficult to quantify, or even qualify risks and opportunities in similar terms so that the proverbial “apples to apples” and not “apples to oranges” comparison occurs. When discussing the philosophical and ethical principles behind calculating risk, Lewens (2007) demonstrates that often the potential damages and benefits of interventions, such as the construction of a new factory near a natural preserve, are not of the same type. On the benefits side you may have more jobs, while on the damages side the destruction of animal species habitat. It may be hard in many cases to be specific about either risks or opportunities in digital government projects as well. This is particularly pronounced in the case of opportunities as they are usually intangible, which makes them difficult to evaluate (Grimsley & Meehan, 2007) and forecast in advance, due to user behavior being complex and unpredictable (Wauters & Lorincz, 2008). When government organizations develop business cases to request funding or justify new IT projects, they are required, ever more stringently, to present hard savings from their innovations and not just describe soft benefits. This puts legacy replacement proposals in a difficult predicament, because the investment required to complete them may seem to outweigh the benefits in the short term (Computer Economics Report, 2011). Similarly, more novel cutting

edge solutions are not seen as investment-worthy, because business case development in government rarely extends beyond demonstrating cost savings (Nielsen & Persson, 2012), and intangible benefit forecasting, futures design, formal creativity techniques, or visionary scenario development are not in the repertoire of skills and analysis methods for most government administrators (Mulgan & Albury, 2003), with maintenance of existing systems seen as a safer investment. As a result, the business cases for novel solutions do not seem as convincing to evaluators.

While the legacy problem is characteristic of many public sector organizations, in some instances there is little resistance to legacy system replacement and their abandonment is proactively sought. The conditions under which this may occur are illustrated by Oliver (1992)'s analysis of "de-institutionalization", or the process by which practices, policies and systems fall out of favor and are de-commissioned by organizations.

Although Oliver does not examine public organizations specifically, her analysis is applicable because government agencies exhibit many of the characteristics of generic organizations and are similarly subject to the impact of environmental, cultural, economic and political factors. She argues that one of the drivers for de-institutionalization is when organizations increase their technical specificity and goal clarity. Although from the 1990s, Oliver's writing appears still valid in today's political climate, where government agencies are under pressure to introduce

efficiencies, improve their services and comply with digital government program mandates. In executing such mandates, goal specificity tends to increase, and the performance standards tend to become more explicit. Consequently, if legacy systems are obstacles to meeting these goals and standards, the organization may proactively move away from them.

Oliver mentions workforce diversity as another condition for de-institutionalization. The entry of government employees of different ages and backgrounds, to whom usage of mainframe systems and old technologies seems counter-intuitive and nonsensical in comparison with the speed and ease of use of newer web applications, will lessen the power and control of those distributional coalitions that favor the old, legacy mode of doing things. Oliver describes this effect as a 'slippage between the institutional template and the exigencies of everyday life' (Oliver, 1992). When seeking solutions to overcome the legacy problem, therefore, more creative techniques that are modeled after online application and technology usage from other domains of life such as education and leisure may prove to be effective.

In their overview of the forces that drive information systems discontinuance in organizations, Furneaux and Wade (2011) investigate,

among others, the effects of the external technical landscape and what they defined as the agencies' "mimetic behaviors": when the IT industry favors more innovative technologies and certain public sector agencies report successes in transitioning to such systems and applications, their peer organizations may engage in similar projects to gain a positive public image and good publicity. If the main drive to overcome the legacy problem is mimetic, however, it can be argued that the effort to replace outdated systems may be only a superficial one, resulting in "front-ending" of the legacy system, but not in impactful back-end business process change.

While the initial wave of digital government has been commonly associated with increasing access to services and exposing information and transactions online, Weerakkody et al. (2011) maintain that the next stage is what they dub "t-Government", or transformational Government: t-Government presupposes an increased focus on changing back-end government operations to meet the objectives of efficiency, transparency, accountability and citizen-centricity. Achieving such deep-reaching transformations requires that government organizations tackle the legacy problem pro-actively and as a systematic effort that is not just long-term, but ongoing: today's systems will be the legacy systems of tomorrow.

Whatever information systems are being built now will always have a pre-existing business or software model that they are based upon: a mobile app may be created as an extension to a classic web application, and while the

latter may not be as inflexible as a mainframe system, it will nonetheless present legacy-type of challenges.

2.3. Legacy as a “Wicked” Issue

While the issue of resistance to change and replication of pre-existing, often inefficient work structures and processes is not unique to the government domain, the legislative and political forces at play in the public sector aggravate it substantially. Public agencies operate in “open societal systems” (Rittel & Webber, 1973), where there is a need to service competing publics, and where it is difficult to pinpoint and predict the exact effects of administrative interventions and system implementations. The differences between the eco-system in which government and industry information systems projects are realized are not merely quantitative – i.e., it is not the case that phenomena such as red-tape or resistance to change are just more pronounced in government. The differences stem in part from the aforementioned lack of goal specificity and quantifiability (Chapter 1) and from inadequate goal formulation. In their seminal paper, Rittel and Weber (1973) examine a category of planning problems defined as “wicked.” Such problems are “vicious” and “tricky” due to the many (often unknown) variables that impact them, due to incomplete knowledge about the problem domain (in the case of legacy systems and processes

there is rarely enough information about the reasons behind their design), due to the lack of definitive problem formulation (legacy system issues have different manifestations in different agencies), and their interconnectedness with other issues (legacy systems changes may introduce unexpected changes to other systems or to business processes in the organization). Combating poverty, reducing crime, improving neighborhood quality of life are classic examples of “grand-scale” wicked problems. An example of the usage of wicked as a description of the seemingly intractable issues faced by government entities, appears in the British public discourse (Bogdanor, 2005) during discussions and reviews of the managerial approach of the Blair Cabinet to persistent “social messes” (Grint, 2005). The active usage of the term (Head, 2008; Australian Public Service Commission, 2007; Termeer, 2012) is an indication of a growing realization that government agencies are faced with issues that defy mechanistic interventions and traditional management approaches based on static departmental structures (Bogdanor, 2005).

Alongside these grand-scale, global problems, Conklin (2006) characterizes certain types of organizational issues as wicked as well. Such issues arise due to the social complexity in modern day organizations: problems such as determining an agency’s mission statement, deciding on the features of a new software product, etc., albeit not intractable or global, are certainly challenges that are not clearly defined (or definable) to begin with, that need to be addressed to the satisfaction of multiple stakeholders with

conflicting interests, and are better handled by a non-linear, less standardized problem-solving process. Along similar lines, Mich et al. (2005) define a sub-category of wicked problems – those that are interdisciplinary, have a dynamic context, uncertain outcomes, many different tradeoffs, but do not necessarily “suffer” from a shifting formulation, and label them “tough problems.” Such problems invariably require a creative approach for their resolution. Therefore, the generalized notion of a legacy problem, where current issues are defined through the prism of old, legacy solutions falls within Rittel and Weber’s class of wicked problems because of its “circularity” – new systems are implemented to overcome the limitations of legacy systems, but the requirements for these new systems are that they conform to business processes shaped by the legacy systems’ outdated architecture and constraints. Such circularity could render the problem difficult to disentangle and hard to manage, i.e. make it intractable. And, based on Conklin’s interpretation, the very presence of multiple stakeholders in a legacy replacement project, makes its dynamics wicked, as stakeholder requirements may be conflicting. Furthermore, the agency specific challenges emerging during legacy system replacement can be convincingly classified as tough problems: they transverse the disciplines of requirements engineering, project management, information technology, strategic planning, organizational behavior, and risk analysis.

While it is tempting to emphasize the individual (psychological) and institutional dimensions of the legacy problem (as these presuppose organizational or people-centric solutions), it can also be seen as a design problem. In her essay *Gardens Need Walls: On Boundaries, Ritual and Beauty*, Perry (2015) discusses the “black box” solutions that reproduce themselves and in doing so limit the design space and prevent new refactorings. These black box solutions have at some point solved certain design problems successfully and have been so historically useful that they have become the new required solutions for somewhat similar, but new problems. As such they ‘tile the world with copies of [themselves].’ The most important question that Perry asks is the one that also motivates this doctoral research: ‘where lies the agency that accepts or rejects certain “black box” structures or tiling systems?’ The answer to this question in the case of legacy systems in government organizations is that such agency invariably lies in a problem-solving and solutions development process powered by a collective of stakeholders representing both technical and business perspectives, or, in Conklin’s (2006) terms, in a form of “collective intelligence”.

Defining the legacy problem as wicked or tough has implications for its solution space and the appropriate tools and methodologies to tackle it. Techniques that center around dialogue, negotiation, consensus-building,

collaboration, or more generally speaking a social process, are deemed more suitable to “navigate” its wickedness (Conklin, 2006).

2.4. Requirements Practices and Methods for Digital Government Solutions

The development of software systems is said to be decidedly dependent on proper requirements (McManus & Wood-Harper, 2008), as requirements engineering is an integral part of the development cycle. After a comprehensive requirements engineering literature analysis, Davey and Parker (2015) have concluded that as individual factor influencing project failure, requirements elicitation activity is significant when compared to other factors. The causes of project failure have been linked to inaccurate, ill-defined, missing, inconsistent, or conflicting functional requirements. Deficiencies in requirements practices have also been linked adversely to the usability of applications – i.e., their ease of use, accessibility, end-users’ sense of satisfaction (Calrshamre, 2001). Online services introduced by government agencies are often plagued by usability issues (Olphert & Damodaran, 2007) resulting from the excessive representation of the internal agency perspective of services (Zweers & Planqué, 2001). From a development and design process viewpoint, requirements methods have been instrumental in documenting design decisions (Rus & Lindvall, 2002),

improving communications between project participants (Coughlan & Macredie, 2002), providing a better understanding of problems of superior complexity (Dix & Schraefel, 2009), improving and automating feature testing practices (Cunning & Rozenblit, 1999) and enabling the development of formal business process, systems or organizational models. Public agencies experience challenges in these areas as well, most notably in effective business team to technical team communications, organizational practice documentation, and solution knowledge transfer (Bresciani et al., 2003). By and large, the factors singled out as critical to the success of digital government projects are closely associated with the concepts and elements which the requirements engineering process consists of.

Conducting the rigorous analytic activities associated for instance with requirements inspection (Shull et al, 2000) and obstacle analysis (van Lamsweerde & Letier, 2000) will likely result in the detection and re-definition of business requirements that unnecessarily mimic legacy system features, or reproduce antiquated business processes. Requirements inspection can be a semi-formal or formal process where requirements are reviewed based on predefined criteria such as quality, consistency, or business value, and consequently with regard to their alignment with organizational goals and higher level organizational strategy. If the government agency touts innovation and the streamlining of

business processes as part of their organizational vision, the practice of requirements inspection may help promote a departure from the organization's technical and business legacy model. Ideally, requirements may be re-written to describe more novel and efficient features. If workplace culture, workforce issues such as the need for re-training, or software and data constraints emerge in the overall technical environment where the legacy system being replaced is utilized, then obstacle analysis (van Lamsweerde & Letier, 2000) can be applied. This technique realizes that the requirements in software specifications often lean towards assumptions of idealized user and systems behavior. For instance, a requirement for the behavior of a replacement system may in fact be innovative, and lead to shortcutting of otherwise unnecessary bureaucratic workflows, however organizational actors utilizing the new system may persistently resort to their old way of doing things. Through formalized means or through informal heuristics, obstacle analysis can help anticipate and highlight these obstacles and even lead to their resolution.

Despite the recognition of their potential for project and process benefits, there is little evidence of systematic adoption and application of formal requirements methods to application development projects in the public sector. Khamooshi and King (2004)'s survey of public agencies in the UK

concludes that there is considerable doubt amongst public sector practitioners in the value of producing requirements specifications. Instead, requirements gathering practices are frequently carried out simply as a form documenting the wish-list of a particular organizational unit, with its interpretation left to developers or systems administrators who often make design or configuration decisions based primarily on technical feasibility. This study is one of few academic publications dedicated explicitly to the significance of requirements practices in government agencies and their unique challenges in the context of digital government. We have also been unable to identify any literature in the requirements engineering field which deals specifically with tools and methods to overcome the legacy problem.

Instead of considering legacy system replacement as an opportunity for simultaneous operational process change, several case studies, particularly from the mid 1990s, make the recommendation for separating technology replacement from business re-engineering undertakings. For instance, Sneed (1995) argues that in order to measure the benefits of switching to a new technology platform accurately, technical and business re-engineering should not be mixed. Similarly, Adolph (1996) argues that the most significant factor for project success is reducing the risk associated with introducing any new features into the modernized system. Even if such approaches can help minimize schedule slippage and simplify deliverables

so that their execution is more feasible, the resultant business value may be lessened. Given government agencies' propensity to be more bureaucratic and transform their processes at a much slower pace than private industry (Boyne, 2002), while a technically healthy system may be produced, business process innovation may never be undertaken at a later phase.

More importantly, the ability to conduct technical modernization of a system without impacting its business content is highly questionable and at odds with current IT governance thinking, according to which business architecture is part of a holistic IT enterprise architecture on par with the data, infrastructure and application dimensions (Josey, 2011).

Furthermore, in the spaghetti code of legacy applications, one is hard-pressed to distinguish genuine business related features from programming tricks introduced for efficiency purposes (Adolph, 1996).

During legacy replacement requirements analysis activities are often time- and scope-wise compressed significantly, due to the assumption that the legacy system itself represents a set of stable requirements that can be quickly captured (Adolph, 1996). However, since legacy documentation rarely exists (Gupta & Bhatia, 2005), this assumption is flawed, and the articulation, and rendering explicit of these requirements tends to be

skipped in favor of direct informal communication between technical staff (the legacy support staff and the developers of the replacement system).

At the other extreme we may encounter excessive business process analysis and review initiatives. Kardasis and Loucopoulos (1998) argue in a similar vein that “paralysis by analysis” often leads to the failure of replacement projects, and that the prospect of endless analysis and current business practice review is a deterrent to attempts at simultaneous platform modernization and feature enhancement. They conclude that despite the risks, this seemingly incapacitating analysis work is nonetheless an opportunity for “knowledge discovery in data”, and from it an assessment of the enterprise’s “to-be” businesses processes can be made. Given the scarcity of documentation of legacy system functions and legacy business processes, the more suitable requirements process is indeed one of discovery and modeling rather than simply capture. They advocate the use of “enterprise knowledge modeling” during legacy information system projects. The components of their modeling framework closely match the activities, elements and outcomes in contemporary requirements engineering methods, e.g., goal identification, stakeholder identification, business rationale definition, mapping of dependencies between information system features and business processes, validation of existing and newly developed business processes, etc.

Another approach in support of the strategic treatment of requirements activities during legacy replacement is that of Aversano and Tortorella (2004). They state that a technical motivation alone is not sufficient to drive the evolution of legacy systems, and that such systems are not stand-alone problems. They maintain that the knowledge embedded in legacy software must be enhanced and augmented by requirements derived from a business model, and propose an assessment process which leads to the definition of system evolution requirements, and the creation and implementation of a new business model based on these requirements. The authors' case study is a local public agency in Italy, and thus is highly relevant to the present analysis of the government organizational context. In their proposed assessment process, the aspects that must be analysed include technologies, organization, processes and legacy systems. The inclusion of legacy systems as an aspect separate from technologies is notable: it corroborates the special status of such systems as a unique interweaving of technology and business elements. Aversano and Tortorella's assessment strategy implies that a balance can be achieved between the legacy constraints and the demands of the business model which necessitates business process re-engineering.

In government, it is often the case that organizational entities are siloed (Weerakkody et al., 2011) and therefore unaware of each other's practices, procedures and uses of data. This highlights the need for a collaborative decision-making and problem-solving process where matters of potential changes to business process are concerned, one that even crosses organizational boundaries (Niehaves & Malsch, 2009). This applies to requirements engineering tasks, because they involve business needs analysis and future (to-be) process modeling, constituent interaction modeling, and therefore a review of legacy constraints and their implications. In this thesis we make the assumption that stakeholder communications and coordination for purposes of requirements analysis, negotiation and prioritization are best enabled by collaboration tools.

2.5. Tool Support for Requirements-Focused Collaboration

The requirements management tools and methods available to practitioners typically require an advanced or in-depth understanding of requirements engineering concepts. Although there is no survey data available on requirements-related tool or practice preferences in the public sector, it is likely that generic office productivity tools such as word processing, spreadsheets, or project templates are used for the purposes of development of a requirements specification document (Matulevičius, 2005), and that requirements discussions (when such take place) are ad-

hoc, since the “requirements engineer” role is not one that can be found in the personnel classifications of local government agencies.

Group analysis and decision processes can be time-consuming, politicized and complicated due to the involvement of multiple stakeholders with diverse backgrounds and priorities. Numerous decision and collaboration support tools and methods have been developed to enable and assist these processes under the research areas of Computer Supported Cooperative Work (CSCW), Group Support Systems (GSS), and more generally Groupware. In the past 20 years, a number of internet tools, labeled as Web 2.0, have emerged, pronounced the next generation of collaboration tools (Prilla & Ritterskamp, 2010). Such tools range from largely unstructured discussion forums to messaging systems, video conferencing, or shared document spaces for concurrent editing, to electronic brainstorming session platforms, or even immersive simulations where users are represented by avatars, and other visual and audio artefacts are employed to enable interaction (Erra & Scanniello, 2010). CSCW, GSS and Web 2.0 tools are an effective means of facilitating group work processes, yet in and of themselves they cannot guarantee neither in-depth analysis of the subject matter discussed, nor effective outcomes, active participation and proper stakeholder representation.

Since the 1990s some of these groupware tools (like email, web conferencing, and file sharing) have become mainstream office productivity tools. They have provided a platform for collaborative activities, but effective moderation and proper problem definition and analysis remain subject to human analytical proficiency. Hartwig (2010) notes that due to problems such as conformity pressures and unmanaged conflict, unfacilitated group interactions in online environments rarely result in sufficient problem analysis. With some of the more generic tools, such as discussion forums, commenting and voting features, the task of topic formulation and deliberation structuring is still left to the human analysts and is thus decidedly dependent on their capabilities, background and cognitive bias. From this perspective the difference between the use of software for discussion and deliberation, and good old-fashioned in-person meetings is not qualitatively substantial, with some arguing that in-person is actually a richer medium (Erra & Scanniello, 2010). While a comprehensive evaluation of the potential use of all existing CSWC, GSS or Web 2.0 tools in the legacy problem context is outside the scope of this study, attention will be given to the theoretical models of deliberation, discussion and argumentation that underlie some of these tools.

One deliberative approach from the 70s, which has re-captured academic interest recently, is the Devil's Advocate (DA) approach (Hartwig, 2010). It

embeds conflict into a 'problem solving procedure through alternate recommendations and critiques of possible solutions by two sub-groups.' Among the benefits of the DA technique is that it does not produce superficial consensus and avoids "group-think" by instilling a "culture of debate." While a lot of contemporary group discussion and brainstorming practices emphasize a style of universally positive acceptance of ideas and opinions (e.g. mantras like 'all ideas are valuable,' 'there is no such thing as a stupid question,' etc.) techniques such as DA create an adversarial and competitive, yet constructive dialogue where the coexistence of certain suggestions and proposals is unattainable. This model fits well with the counterposing of legacy and innovation themes inherent in the formulation of the legacy problem. Hartwig points out that in groups in which conflict is a part of the deliberation dynamics, higher quality decisions are produced in comparison to groups where consensus is primarily exhibited. If the notion of conflict is deconstructed, one of the core elements observed is that of the "challenge." Conflict, or the assuming of opposing positions, involves a challenge to the fit or the accuracy of a proposed idea or solution. When such a challenge is posed, the sub-group that was challenged must defend its position by making available supporting evidence and facts that promote its viewpoint. From this perspective, challenge-based, dialectically-structured dialog is valuable because it increases the amount of information available about the business

environment hence addressing the epistemic uncertainty issue inherent in the legacy problem.

Requirements analysis activities exhibit similar characteristics when their dynamics are decomposed. Potts et al.'s (1994) model of requirements argumentation reveals an inquiry-driven cycle, where the concept of challenge can also be observed, and where this challenge represents the questioning of a specific requirement. This is depicted in Figure 1. To satisfy a challenge one must answer questions regarding the need for the requirement in its current form by stating a reason for it. This answer forms the basis of discussion, after which a decision can be reached regarding if and how the requirement must be changed.

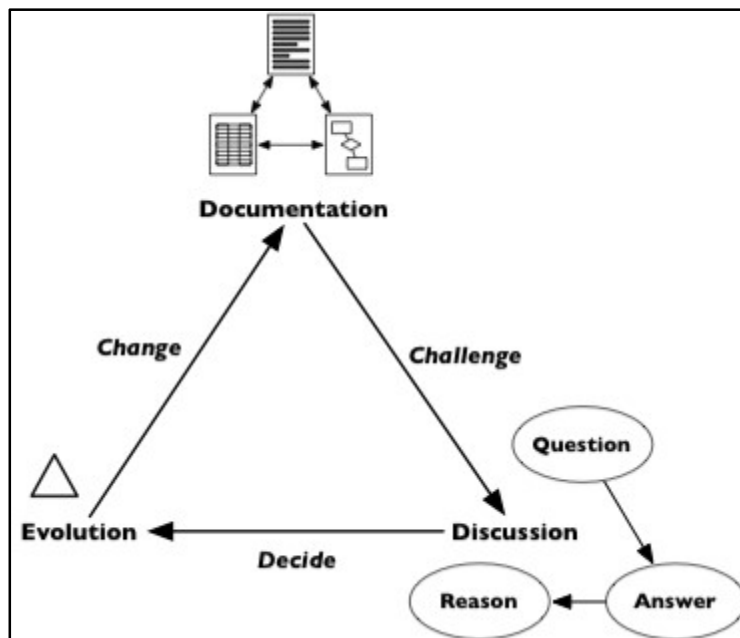


Figure 1. The Potts et al.'s Inquiry Cycle Model (image obtained from <https://www.ics.uci.edu/>).

Another example of a conceptual model developed to support the deliberation and reasoning process during design is the Issue-Based Information System (IBIS) authored by Kunz and Rittel (Kunz & Rittel, 1970). The system is specifically equipped to tackle wicked issues: it makes explicit these issues and enables participants to put forth arguments for and against certain positions. It makes it 'harder for discussants to make unconstructive rhetorical moves, such as "argument by repetition" and name calling, and it supports other more constructive moves, such as seeking the central issue, asking questions as much as giving answers, and being specific about the supporting evidence of one's viewpoint' (Conklin & Begeman, 1988, cited in Ocker, 2010). A graphical user interface and some GSS features were created on top of this framework and the software platform gIBIS was established. The benefits of the framework were that factors related to peer-pressure and "power moves" during face-to-face meetings were removed from the discussion, thus allowing for focus on the essentials.

One issue with existing CSCW, GSS and Web 2.0 tools is their taking for granted practitioners' motivation and concentration when collaborating online. 'Attention is the organization's scarcest resource' (Hengst & Vreede,

2004) and participants in business requirements analysis activities might have difficulty sustaining their focus on analysis for longer periods of time. Once again, adequate participation relies on mechanisms and factors outside the functions of the tools and the online environment itself and it is not reasonable to expect collaboration tools to compensate for unfavorable conditions in organizational culture, or to substitute for skillful facilitators. However, when dealing with something as complex and tough (Mich et al., 2005) as the legacy problem at the functional requirements level of digital government application development projects, it is necessary to attempt to provide a structure that addresses the characteristics of the legacy problem as directly as possible.

Potts et al.'s model, IBIS and the Devil's Advocate technique represent deliberation models which are suitable to address the legacy problem in a digital government context, where requirements discussions can be 'cast as a dialectic between old memory and new knowledge' (Robey et al., 2002).

Few contemporary tools, however, support either of these three models or techniques with sufficient fidelity. Among the ones that do are tools like Compendium (Shahin et al, 2010) and Dialogue Mapping (Conklin, 2006) which introduce the ability to visually represent diverging view points, new ideas and decisions reached, thus mapping the interactive process of group discussion over a topic that needs action-based closure. Any group

collaboration tool applied to the design process of new systems which must simultaneously satisfy new business requirements and historically justified demands must accommodate challenge-based deliberation, where conflict can be explicitly managed so it can be productive. Dialogue Mapping includes markers for questions, pros, cons, and ideas, while Compendium also introduces the concepts of notes and decisions. Such tools can be applied to the discussion of business requirements and open up the possibility for eliciting divergent ideas and attitudes towards “legacy-leaning” features. The proper use of these platforms and their notation elements, however, is dependent on a skilled moderator, or note-taker (Conklin, 2006), and would be contingent upon sufficient engagement of all stakeholders if the meetings they document are in-person, or not anonymous. The earlier discussion on wicked problems highlighted that solution-seeking for wicked, complex or tough issues must depart from previously adopted problem-solving “templates” and accommodate a non-standard (e.g. not meeting-based), or non-linear process of problem solving (Conklin, 2006). Therefore, in addition to conflict management, tools supporting practitioners dealing with the legacy problem must enable creativity and imagination (Brown et al., 2010).

2.6. Creativity in Requirements Engineering

Some have argued that requirements engineering is itself a creative process (Maiden & Gizkis, 2001 cited in Kauppinen et al., 2007) and a driver of innovation (Kauppinen et al., 2007). Robertson (2002) even touts requirements analysts as potential “inventors” of new requirements. Svensson (2012), however, notes that there is little research in RE to address creativity and a lack of creativity theories and models to inform current RE practice. This is confirmed by Kauppinen et al., who observed industrial RE processes in Finnish companies and concluded that idea creation is rarely integrated with RE practices: creativity is not emphasized in RE processes, because the focus is overwhelmingly on complete and consistent requirements documentation. The authors derive a number of suggestions for practitioners to ameliorate this situation, with the one most pertinent to legacy replacement projects being that of integrating idea creation and RE activities by expressing those ideas as requirements. A tool that systematically enables this could potentially contribute to addressing the legacy problem in government systems replacement projects.

Traditionally, creative outcomes in requirements activities are sought through brainstorming sessions, in their many variations like Brainwriting 6-3-5 (Michinov, 2012), future workshops (Biskjaer et al., 2010), etc. There have also been requirements engineering creativity workshops (these will be referred to succinctly as “creativity workshops” from now on) that apply

different techniques such as analogical reasoning, information visualization, fusion cooking and storyboarding (Maiden et al., 2004). Of those, it is Maiden et al.'s application of role-playing in such workshops that has substantially inspired the creativity approach in this thesis. The authors employ role playing as a conflict resolution strategy and as a way of providing a more conducive environment for participants to exercise different types of creativity: exploratory creativity, defined as the search for ideas and solutions through the study of the problem and its context; combinatorial creativity, as the combination of existing ideas in novel ways; and transformational creativity as “out-of-the box” development of new concepts. The authors employed the explorer, artist, judge, and warrior roles (Von Oech, 1986), which allowed participants to engage in the creative process from different perspectives. We will return to Maiden et al.'s work on roleplay and creativity inducing techniques in Chapter 4, Section 4.2., where we discuss the theoretical foundation of our game-based approach.

When revisiting the typical organizational attitudes towards legacy system change – namely that of risk aversion which favors legacy feature replication, and the innovative attitude which sees new technologies as an opportunity for business process transformation – the suitability of a role-

playing exercise for the requirements discussion comes to the forefront. Since the related roles for these two different attitudes are directly juxtaposed (unlike the somewhat complementary roles in Maiden et al.'s workshops), a version of creativity methods would have to be developed and employed that helps structure conflict around certain perspectives and makes disagreement productive.

As noted by Milne and Maiden in a recent analysis (2012), requirements engineering activities are perpetually impacted by organizational politics and power relationships. More importantly, key requirements and high-level goals are originally 'constructed through a political decision process' (Milne & Maiden, 2012) so their questioning might be construed by organizational practitioners as a subversive act per se. The requirements engineering discipline must incorporate recognition, analysis, and sensitivity to organizational politics and conflict in order to support the elicitation, analysis and management of better requirements, but research approaches like ethnography, social network analysis or the production of Social Dependency Diagrams, to name just a few examples, are too time-consuming and even "intrusive" (Milne & Maiden, 2012). Alternative approaches from other domains must be sought to aid with the conflict and power dimensions of the legacy problem.

Structured conflict and competition are concepts native to the domain of game design, thus necessitating a review of the use of games in organizational settings and a look at how game elements can be introduced to make decision-making and problem-solving tools more efficient and effective.

2.7. Serious Games and Gamification

The business analysis and application development methodologies of preference in government agencies are those that are standardized, well-established and highly structured, e.g., waterfall approaches to the systems development life-cycle (Pardo & Scholl, 2002; Iivari & Huisman, 2007), capability assessments, workflow process analysis, standard systems specifications, and so forth. While incremental process and service innovations can be observed in the public sector, experimental techniques and innovative approaches are rarely adopted unless introduced to the organization by external pressures or sources, such as consultants (Dent, 2002; Bessant & Rush, 1995). In fact, there have been claims that innovation is not an elemental aspect of the public sector (Potts & Kastle, 2010).

A relatively recent trend in education has been the development and use of games and game-like simulation for learning, collaboration, knowledge-sharing and training. This movement has been referred to as “serious games” or “serious gaming” (Charsky, 2010). In government, while occasionally attempted (Crookall, 2010; Burke, 2012), game utilization is still rare, despite evidence of the benefits of games and simulations for addressing a wide range of problems in various domains. Key advantages of game-like methods pertinent to the legacy problem in digital government, and to requirements engineering activities for legacy replacement projects in the public sector, are their participative safety, competitive drive, emotional impact, and stimulation of creative solution development. By establishing an environment that is “quasi-realistic” (Klievnik & Janssen, 2010), games allow for actual business situations to be simulated. The advantages of using simulations have been highlighted by researchers, who have argued that participants in a simulation may be more proactive because the simulated context provides a “safe” space to try novel approaches and be experimental (Mainemelis & Ronson, 2006; Ocker, 2010). Safety in this context has dual significance – both as safety to err, but also in the sense of freedom from organizational or inter-personal pressures. Specifically, Ocker (2010) highlights the benefits of anonymity in electronic brainstorming, resulting in a non-judgmental environment, conducive to risk-taking.

Another core characteristic of games is the element of competition, or a dialectical dynamic, where the instinct to win, or out-do an opponent is an accepted and benign form of behavior (Mainemelis & Ronson, 2006). In contrast, in other contexts, disagreement, aggression and similar conduct may be discouraged and considered unprofessional. The emphasis on competition and argument in a game setting could pair well with the nature of the legacy problem, as one involving a juxtaposition of conservatism and business transformation. A dialectically designed game would enable opposing positions to be made evident/explicit as part of the goal of the game.

The affective components of a game provide additional value to the exploration of the organizational dynamics we are interested in. Systems implementation activities do involve emotional aspects (Nelson, 2005), and ascribing risk to certain requirements specifications for application development is certainly rooted in affect (Slovic et al., 2004). By incorporating game actions, rules and outcomes that express, or result directly from affect, feelings in requirements activities and feelings during exercises in innovation would be addressed explicitly. Maiden et al. (2004) note the importance of letting participants 'let off steam' and have

‘shouting sessions’ prior to engaging in creative brainstorming , as this removes inhibitions and accumulated frustrations, enables teamwork and an un-encumbered perspective on the business problems discussed.

One of the greatest advantages of employing a game is its potential to enable creativity and problem-solving (Zichermann & Cunningham, 2011). Creative new requirements and transformations of existing requirements are instrumental to overcoming the legacy problem. The “situationalist” view of creativity, defined by Nguyen et al. (2009) refers to the non-individualist, communal nature of creativity. Creative expression is seen as influenced primarily by the social environment, making it particularly suitable for requirements activities: it can be aligned with some essential requirements engineering concepts such as negotiation, prioritization and communication of requirements. Requirements games, such as Prune the Tree – for the creation of a product roadmap through requirements development, and Buy a Feature - for the prioritization of requirements in product releases, described in detail by Ghanbari et al. (2015) have demonstrated success in fostering innovation and collaboration in distributed teams, and in improving the quantity and quantity of elicited software requirements.

The integration of gamification and serious games with employee performance management or enterprise innovation platforms has become

fairly common in industry and is key strategy to engage employees and seek out innovative ideas (Burke, 2012). Idea management and gamification are identified as highly complementary in knowledge work (such as requirements engineering activities), and with properly designed enterprise tools organizations could see ‘an explosion of gamified crowdsourced innovations by 2020’ (Burke, 2012). Some government agencies have already utilized idea crowdsourcing and have gamified their employee suggestion programs, but they have rarely applied games to tackle specific domain problems and improve project outcomes. The legacy problem is a suitable use case for game-based intervention, as it is a problem that emerges during requirements activities, which are knowledge intense, require collaboration and benefit from creative thinking.

2.8. Chapter 2 Summary

A review of digital government and public administration literature has revealed a substantial body of academic and business research on the dynamics of unsuccessful digital government system implementations and large digital government initiative failures. The explanations include general information systems project challenges, aggravated by the political and bureaucratic constraints of government agencies.

This review has demonstrated that the legacy problem is a significant obstacle to the success of digital government initiatives, and practitioners' decisions in favor of risk avoidance lead to information systems and business solutions that largely promulgate the status-quo. What we have referred to as the legacy problem is partially an expression of the attitudes of risk and change aversion prevalent in public sector management, but upon closer examination of relevant literature, it seems that other factors contribute to the problem too, e.g. cognitive dissonance, the inability to foresee and control the effects of business change, the complex relationships with constituents, the challenge of fulfilling the diverse requirements of multiple stakeholders, as well as intra-organizational dynamics. It is therefore suggested that the legacy problem and the larger phenomenon of legacy system embeddedness in organizational practice and business operations are wicked problems for public administrators.

Risk aversion is often assumed to be resultant from rational and objective decision-making, however the research on risk analysis in local government IT projects demonstrates the lack of a systematic approach to business process change-related risks, and also a disregard for the potentially positive outcomes associated with change and innovation. The

notion of risk assessment prevalent in research is problematic when applied to the process of legacy replacement for a number of reasons:

- 1) qualifying the departure from legacy systems as risky is often anecdotal, and emotionally loaded;
- 2) the risk management activities during information systems project are generally more fine-tuned towards assessing and mitigating project logistics risks such as schedule, cost and resources;
- 3) opportunities for improvement are not adequately represented and factored into a “risk equation”;
- 4) business process change itself is labeled as a project risk.

Another issue that aggravates the legacy problem is the insufficient attention paid by government practitioners to requirements engineering principles, activities and methods. No major studies have been dedicated to studying the state of requirements practice in local government in the past decade and only a limited number of case studies are available to demonstrate best practices such as engagement of constituent stakeholders. More importantly, there is evidence that legacy systems features are directly used as specifications for new systems' functionality.

Legacy replacement projects, therefore, are in danger of shortcutting the business requirements process in favor of minimizing risks to the timeline. Furthermore, the possibility that business requirements are derived from

the technical features of a legacy system, without being validated for their currency, business value and strategic viability is high. Increased attention must be paid to the requirements analysis and development phases, where the sustained focus on solution design and development pays off in more ways than just successful project completion.

No groupware and requirements tools have been developed to date to help practitioners tackle the legacy problem specifically. For collaboration tools to be effective, they must be based on an appropriate model of interaction, and on a consensual representational model of the problem that must be solved. Such a model should enable group reasoning to address legacy issues by critiquing individual functional requirements as part of the application scoping and development process in a digital government context, and allow for the explicit juxtaposition of the legacy preservation position to alternative innovation viewpoints. Hence an assessment of the communication dynamics that underlie legacy problem discussions must be made. Deliberation approaches, such as the Devil's Advocate technique and Potts et al.'s inquiry cycle model, could provide the foundation for a relevant tool.

The recent developments in the areas of serious games and gamification have revealed their potential for tackling complex problems and wicked issues. Games can make activities which require sustained concentration,

such as requirements engineering, more engaging and interesting, and analysis tasks where opposing viewpoints emerge more productive, by managing conflict in an explicit and playful manner. The literature review has found few examples of the use of games to directly aid decision-making during requirements activities – games have been used in the RE field primarily for educational purposes. The application of games in the context of digital government has also been limited. The exploration of a game-based approach to address the legacy problem in local government agencies is therefore a novel line of inquiry, with the potential to yield valuable insights. The need for legacy-focused requirements analysis and negotiation methods and the requisite tool support for them have been established throughout this chapter, hence a key research objective of this dissertation is the development and evaluation of a prototype tool with game elements to assist government employees in the discussion of requirements during legacy system replacement projects.

Chapter 3: Primary Research - Online Survey and Practitioner Interviews

This chapter features a detailed account of the first phase of primary research into the legacy problem in the public sector, specifically involving an online survey and a series of qualitative interviews. It is organized as follows. The online survey developed to assess the prevalence of legacy systems in government agencies and the practices associated with their replacement is described in terms of design and collection procedures in Section 3.2.1. Next, the findings of the survey are reported and discussed in detail (Section 3.2.2.). Methodological limitations are presented in section 3.2.4. Section 3.3 describes the qualitative interviews carried out as a follow-up to the survey, while in the interview findings section (3.3.2), emerging themes are singled out. Interviewees' feedback on the proposal for creating a requirements game that focuses on the legacy problem in the requirements phase of legacy systems replacement projects is summarized in section 3.3.2.6. The methodological issues associated with the interviews are presented in section 3.3.4. The chapter concludes with a discussion consolidating the outcomes of both research efforts –survey and interviews.

3.1. Introduction

Due to the absence of comprehensive studies to establish the extent of the legacy problem in the public sector, the collection of quantitative and qualitative data to illustrate the dynamics of legacy systems replacement projects described throughout the literature review and introductory chapters of this dissertation became a key research deliverable in the present study. Several recent reports focus on legacy-related issues in government; however, being either national case studies (National Audit Office, 2013) or briefs that primarily reveal the financial and budgetary dimension of reliance on legacy systems at the federal level of US government (Charette, 2016), their coverage of the scope of the legacy problem in the public sector is only partial. They also do not interweave the threads of legacy replication, requirements practices and the risk-averse bureaucratic culture in government. The survey and qualitative interviews described in this chapter attempt to make this connection and to create a fuller picture of the legacy problem and its multiple dimensions.

In 2013 the National Audit Office in the United Kingdom issued a report ordered by the House of Commons entitled *Managing the risks of legacy ICT to public service delivery* (National Audit Office, 2013). The report reveals the financial and organizational aspects surrounding legacy systems in

several agencies and defines the continued use of legacy systems as a risk per se: the preservation of technology that is outdated, hard to maintain and difficult to extend functionally is an obstacle to '[delivering] the level of transformation envisaged by the government's digital strategy.' Four case studies are featured, which include systems with major functions and large-scale monetary impact. The report asserts that managing legacy systems is an integral element of public service delivery, rather than a set of isolated or transitory projects focused solely on technical upgrades. It also singles out the legacy system replacement route, among several organizational approaches, as the most conducive to comprehensive organizational transformation.

This dissertation argues similarly that even if legacy systems are discontinued and replaced with new applications, it does not follow that substantive, significant or improvement-inducing changes are made in the organization's business processes. The aims of our research is not only to reveal if legacy systems are being replaced, but to determine how their replacement is undertaken in current practice- if a technology face-lift is performed, or if opportunities for deeper business transformation are taken advantage of. The way government agencies manage their legacy systems and the transition away from them (both in terms of technology and work processes) impacts their capacity to innovate and to improve

public services to their constituents. As a very first step this research opted to “canvass the field” by employing an online survey.

3.2. Survey

The survey aims to fulfill two key research objectives:

1) *to characterise the current state of requirements engineering practices in digital government projects which involve legacy system replacement.*

For this purpose it inventories the prevailing requirements activities during legacy replacement projects and singles out those of them considered particularly useful by practitioners.

2) *to establish the extent to and manner in which legacy systems and business processes are reproduced in new solutions and applications.*

The survey directly asks respondents to “size” the degree of feature replication in their agency’s projects, and also features questions about the sources of replacement system requirements.

3.2.1. Method

An exploratory online survey was developed to gauge the extent of the legacy problem in quantitative terms and to examine how government organizations are dealing with it. The survey instrument consisted of 29 questions divided in 4 sections. Its design and results are presented based on principles and recommendations for conducting software engineering empirical research (Kitchenham et al., 2002; Easterbrook et al., 2008).

3.2.1.1. Questions

The first section dealt with the scope and characteristics of the legacy problem, i.e., the problems as well as the benefits presented by maintaining legacy systems, the criticality of legacy systems, the effort dedicated to legacy system replacement, and preferred approaches to their replacement. The scope of the legacy problem was assessed by asking about the staff resources dedicated to projects involving legacy systems replacement. However, unlike the UK Auditor's Office study (National Audit Office, 2013), questions regarding the budget dedicated to legacy system maintenance or questions about funds collected and managed with legacy systems were not asked, largely because respondents may not possess this knowledge, and if they do, it may not be verifiable.

The second section of the survey dealt with the impact of legacy system

replacement projects on the respondents' organization, including the organization's primary concerns with the implementation of legacy replacement systems, emerging issues, and the typical level of carry-over of features from legacy systems into new applications.

The third section focused on specifics of the requirements and business analysis practices undertaken during legacy replacement projects – how these requirements are collected and analyzed, who performs these activities, and which methods and techniques are useful.

The fourth section collected information about the survey respondents, the size and type of their organizations, respondents' roles and background, and other similar questions.

All survey questions are featured in Appendix A.

3.2.1.2. Survey Population and Data Collection Procedures

The web link to the survey was disseminated via email to several distribution lists of digital government practitioners, and it was also posted

on professional community groups on social networks such as LinkedIn, Google+, Facebook, etc. The cumulative reach of all these communication methods is over 1000 recipients, however it is not clear how many actually received and read the invitation to participate in the survey. It is therefore impossible to size the survey target population and determine accurately a response rate.

36 full and 3 partial responses were received (partial responses are included in the data tables whenever applicable). A total of 100 users clicked on the survey link (i.e., accessed the first page which contains the description of the project and the survey). The characteristics of the respondents who fully completed the survey are presented in the Table 2 below.

Table 2. Characteristics of Survey Participants

Total Number of Full Responses: 36
Level of Jurisdiction of Respondent’s Organization:
68.6% (25) Local/County/City
17.1% (6) State/Regional
14.3% (5) Federal/National
Legacy system replacement project direct involvement
80% (29) - Yes (currently involved)
8.6% (3) - Yes (involved in the past)
11.4% (4) - No – not directly involved
Respondents’ Organizational Role
28.6% (10) IT Manager

20% (7) Business/Operations Manager
17.1% (6) Executive Level (CEO, CIO etc.)
11.4% (4) Other IT specialist
8.6% (3) Business Analyst
5.7% (2) Systems Developer
5.7% (2) Systems Administrator
2.8% (1) Other

Respondents' Agency Size

57.1% (21) Over 1000 employees
34.3% (12) 100-1000 Employees
8.6% (3) Under 100 Employees

Respondents by Country

61.1 % (22) United States
22.2 % (8) United Kingdom
8.8 % (3) Canada
5.6 % (2) Netherlands
2.8 % (1) Romania

In summary, 88.6% (32) of the respondents who fully completed the survey were either currently directly involved in legacy system replacement projects, or had been involved in such projects in the past. Approximately half of the respondents were Information Technology (IT) specialists. The majority represented large government agencies. Most of them (25) were from North America (the United States and Canada). 11 were from European Union countries, including the United Kingdom. The responses were collected over a period of 6 months.

3.2.2. Results

The survey results are reported in the grouping and order the questions were posed to the respondents. Key findings are summarized first. All responses are presented in tables (with the number of specific responses displayed along with the percentage of the total they represent, per best practices in survey reporting outlined by Kitchenham et al. (2002)). Following each table is a summary of the free-form textual responses which the survey participants wrote in in the “Comments,” or “Other” field, if one was available in the respective question.

3.2.2.2. Questions Regarding Legacy Problem Characteristics and Scope

97.6% (35) of respondents’ organizations have a business-critical legacy system. For 34% (12) of these organizations, most or all business-critical systems are legacy systems.

Table 3. Question: “How would you characterize your organization’s reliance on legacy systems?”

All business-critical systems are legacy systems	2.4% (1)
Most business-critical systems are legacy systems	21.9% (8)
Some business-critical systems are legacy systems	53.7% (19)
A few business-critical systems are legacy systems	19.5% (7)
No business-critical systems are legacy systems	2.4% (1)

Approximately 64% (23) of respondents indicated a moderate-to-large extent of effort (represented as number of staff members involved in dedicate projects) to replace legacy systems.

Table 4. Question: “What is the extent of the effort your organization is making to replace its legacy systems (feel free to approximate)?”

A large number of staff, and/or large budget	24.3% (9)
A moderate number of staff, and/or moderate budget	40.5% (14)
A small number of staff, and/or budget	24.3% (9)
No effort is currently taking place	10.8% (4)

In terms of impact to their organizations, respondents highlighted the inability to accommodate new business needs, limited integration capabilities and high maintenance costs as the top three issues resulting from the reliance on legacy systems.

Table 5. Question: “Below is a list of issues that may result from the reliance on legacy systems. Please specify the impact they have on your organization” (37 responses)

No Impact	Low Impact	Moderate Impact	High Impact	Very High Impact
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Limited customization flexibility	0% (0)	8.1% (3)	31.1% (11)	42.3% (16)	18.5% (7)
Over-reliance on external/vendor support	2.7% (1)	2.4% (1)	42.3% (16)	41.5% (15)	10.8% (4)
Slow change management processes	0% (0)	2.7% (1)	35.2% (13)	35.2% (13)	26.8% (10)
Inability to accommodate new business needs	2.7% (1)	8.1% (3)	18.5% (7)	43.9% (17)	26.8% (10)
Limited Integration Capabilities	2.7%(1)	8.1% (3)	18.5% (7)	43.9% (17)	26.8% (10)
Maintenance costs	2.7% (1)	12.4% (5)	26.8% (10)	41.5% (15)	17% (6)
Other	31.1% (11)	0% (0)	5.4% (2)	10.8% (4)	5.4% (2)

Several survey respondents completed the free-text section of this question. Some of them conveyed that legacy systems introduced issues with over-reliance on a small number of employees with knowledge of the legacy system (employees who might also be near retirement age), others - that such systems cannot be used efficiently in a distributed manner, and that data exchange and interfaces with other application require manual efforts.

In terms of benefits from legacy systems, respondents ranked staff familiarity and system reliability as the highest for their organizations. However, most respondents indicated that such benefits have a low impact.

Table 6. Question: “Relying on legacy systems may introduce certain benefits. Specify the impact of each benefit on your organization.” (39 responses)

	No Impact	Low Impact	Moderate Impact	High Impact	Very High Impact
High staff familiarity with the system	7.7% (3)	17.9% (7)	33.3% (13)	25.7% (10)	15.4% (6)
System reliability	5.1% (2)	15.4% (6)	35.9% (14)	33.3% (13)	10.3% (4)
Low maintenance costs	15.8% (6)	34.2% (13)	28.9% (11)	18.4% (7)	2.6% (1)
Well-running change management processes	7.9% (3)	44.8% (17)	23.7% (9)	18.4% (7)	5.3% (2)
Other	77.8% (14)	0% (0)	11.1% (2)	5.55% (1)	5.55% (1)

A respondent noted in the free-text (“Other”) field specifically that the costs of identifying, documenting and re-coding the business rules embedded in legacy systems are extensive.

3.2.2.3. Questions Concerning Legacy Replacement Work and Feature

Carryover

The majority of respondents indicated that they implement COTS (Commercial Off-The-Shelf products) to replace legacy systems often or in some cases always.

Table 7. Question: “What is your organization’s preferred approach to legacy systems replacement? (Specify how commonly each approach is applied.)”

	Always	Often	Sometimes	Rarely	Never
COTS	8.1% (3)	62.2% (22)	27% (10)	2.7% (1)	0% (0)
SAAS	5.7% (2)	22.9% (8)	37.1% (13)	31.4% (11)	2.9% (1)
In-house development	2.8% (1)	22.2% (8)	27.8% (10)	33.3% (12)	13.9% (5)
Outsourced development	5.6% (2)	19.4% (7)	22.2% (8)	44.4% (16)	8.3% (3)
Other	2.8% (1)	5.6% (2)	2.8% (1)	0% (0)	33.3% (12)

In terms of the impact of legacy replacement projects to their organizations’ operations, respondents indicated that such projects introduce (in order of magnitude of impact) – 1) changes to operational procedures, 2) the need to train or –re-train staff, 3) organizational policy changes.

Table 8. Question: “How would you characterise the wider business impact of of legacy replacement projects in your organization? (Select all that apply)”

	Very High Impact	High Impact	Moderate Impact	Low Impact	No Impact
Changes to Operational Procedures	19.4% (7)	61.1% (22)	16.7% (6)	2.8% (1)	0% (0)
(Re-)Training of Staff	30.55%	36.1% (13)	25% (9)	8.3% (3)	0% (0)

	(11)				
Organizational Policy Changes	11.1% (4)	36.1% (13)	44.4% (16)	5.6% (2)	2.8% (1)
Changes to Staffing Levels	8.3% (3)	33.3% (12)	22.2% (8)	33.3% (12)	2.8% (1)
New Organizational Roles	2.8% (1)	30.55% (11)	50% (18)	13.9% (5)	2.8% (1)
Other	0% (0)	2.8% (1)	2.8% (1)	0% (0)	36.1% (13)

Other issues respondents' organizations were concerned with during legacy system replacement projects include reduced resource levels available to support new systems, technical integration challenges, lack of knowledge about new technologies, lack of knowledge about business rules in the organization, and the lack of transparency in project-related communication.

Over 42% of responses indicated that a lot, or almost all of legacy system features carry over into the new replacement system.

Table 9. Question: "How would you characterize the level of carry-over of features from legacy systems into the new applications that replace them?" (37 Responses)

Almost all legacy features carry over	5.7% (2)
A lot of legacy features carry over	37.1% (14)
Some legacy features carry over	37.1% (14)

A few legacy features carry over	11.4% (4)
No legacy features carry over	8.6% (3)

According to respondents, the reasons for feature carryover from old-to-new replacement systems are (in order of frequency of occurrence): 1) the desire to minimize changes, 2) end-user habit, 3) legislative and policy mandates.

Table 10. Question: “Why do old system features typically carry over in the new application(s) that replace legacy systems? Specify the frequency with which these factors play out in your organization.”

	Always	Often	Sometimes	Rarely	Never
To minimize changes to business operations	5.55% (2)	58.3% (20)	25% (9)	5.55% (2)	5.55% (2)
Mandated by policies or legislation	16.7% (6)	41.7% (15)	30.6% (11)	8.3% (3)	2.8% (1)
Because end-users are accustomed to them	11.1% (4)	47.2% (17)	19.4% (7)	13.9% (5)	8.3% (3)
Because they have been stable for years	5.55% (2)	22.2% (8)	47.2% (17)	16.7% (6)	8.3% (3)
Because tech. specifications for them are readily available	5.55% (2)	22.2% (8)	25% (9)	33.3% (12)	13.9% (5)

Respondents cited several additional reasons for feature carryover, which were not listed as response options in the survey. These include software/hardware requirements, emotional investment on behalf of users

and administrators, integration requirements and dependencies on other systems, and data continuity concerns.

3.2.2.4. Questions About Requirements Practices Utilized in Legacy Replacement Projects

Although the focus was not to detail out the diversity of requirements engineering practices and methods employed in government agencies, an exploration whether the replacement of legacy systems was approached differently than other types of information technology projects in terms of requirements gathering was of primary interest. Since there have not been any comprehensive recent studies on requirements practices in government IT since 2004 (Khamooshi & King, 2004) there is no definitive comparative basis to use to juxtapose the requirements approaches taken for legacy replacement projects to those for the procurement and development of systems without predecessors. With this in mind, the question was framed in terms of requirements “sources,” in order to more specifically evaluate the potential carryover from legacy systems.

The three most useful sources of requirements in order of ranking by respondents were: 1) interviews with business users, 2) technical documentation and 3) interviews with IT staff.

Table 11. Question: “Below is a list of potential sources of business requirements for the new applications/services replacing legacy systems. Please specify how useful they were for the projects you are familiar with, or involved in.”

	Most Useful	Very useful	Somewhat Useful	Barely Useful	Not Useful
Interviews w/ business users	27.8% (10)	52.8% (19)	16.7% (6)	0% (0)	0 % (0)
Technical documentation of existing/previous system	5.55% (2)	47.2% (17)	25% (9)	5.55% (2)	5.55% (2)
Interviews w/ IT staff	8.3% (3)	41.7% (15)	41.7% (15)	0 % (0)	5.55% (2)
Focus Groups	5.55% (2)	33.3% (12)	27.8% (10)	13.9% (5)	5.55% (2)
Surveys of End Users	16.7% (6)	19.4% (7)	27.8% (10)	22.2% (8)	2.8% (1)
Studies by consultants/other orgs	0.0% (0)	36.1% (13)	22.2% (8)	22.2% (8)	13.9% (5)
Market research into best practices	2.8% (1)	27.8% (10)	41.7% (15)	13.9% (5)	5.55% (2)
Notes from project meetings	2.8% (1)	25% (9)	44.4% (16)	13.9% (5)	5.55% (2)
Legacy system training manuals	2.8% (1)	22.2% (8)	11.1% (4)	33.3% (12)	5.55% (2)
Legacy Code	0.0% (0)	19.4% (7)	33.3% (12)	13.9% (5)	16.7% (6)
Social Media Research	0.0% (0)	13.9% (5)	22.2% (8)	25% (9)	8.3% (3)

The functional roles most often responsible for gathering, documenting

and analyzing requirements in legacy replacement projects in order of ranking were: 1) Project Managers, 2) Business Analysts and 3) Systems Analysts.

Table 12. Question: “Who typically carries out the gathering, documenting and/or analysis of requirements during legacy replacement projects in your organization?”

	Always	Often	Sometimes	Rarely	Never	No such position in my agency
Project managers	33.3% (12)	25% (9)	27.8% (10)	11.1% (4)	2.8% (1)	0% (0)
Business analysts	22.2% (8)	36.1% (13)	22.2% (8)	8.3% (3)	0% (0)	11.1% (4)
Systems analysts	19.4% (7)	38.9% (14)	19.4% (7)	8.3% (3)	2.8% (1)	11.1% (4)
Developers	16.7% (6)	22.2% (8)	30.55% (11)	22.2% (8)	0% (0)	8.3% (3)
Interface Designers	5.55% (2)	16.7% (6)	25% (9)	13.9% (5)	2.8% (1)	36.1% (13)
Usability Analysts	2.8% (1)	13.9% (5)	13.9% (5)	13.9% (5)	2.8% (1)	52.8% (19)
Technical Writers	2.8% (1)	5.55% (2)	16.7% (6)	16.7% (6)	11.1% (4)	47.2% (17)
Outreach specialist/PR/Marketing/Public Information specialists	0% (0)	8.3% (3)	25% (9)	25% (9)	22.2% (8)	19.4% (7)
Administrative Staff	8.3% (3)	22.2% (8)	22.2% (8)	22.2% (8)	25% (9)	0% (0)
Consultants/Contractors/Vendors	13.9% (5)	33.3% (12)	44.4% (16)	2.8% (1)	2.8% (1)	2.8% (1)
Requirements Analyst/Requirements Engineer	19.4% (7)	16.7% (6)	13.9% (5)	8.3% (3)	0% (0)	41.7%(15)

The survey question “How often do individuals in these roles/positions carry out gathering, documenting and/or analysis of requirements during legacy replacement projects in your organization?” was designed to establish if the requirements elicitation process for legacy-related projects is dominated by IT staff. The aim was to gauge if legacy replacement is primarily perceived as a technological issue.

In this section of the survey respondents were also asked to specify, in their own words, what processes their organizations follow during legacy system replacement projects. The question was deliberately designed to be open-ended, and its formulation did not specify if a requirements engineering process, or a business management process is being referred to, as organizations may not categorize their processes using such a classification. Respondents singled out process mapping and new process updates, business process review, informal functional inventories. They also noted that the direction a legacy replacement project takes in respect to feature carryover has a strong dependency on senior management approval, on the influence of staff responsible for the systems being replaced, and on governance board-determined direction.

3.2.3. Discussion

Even though the number of survey responses was not particularly high, it must be noted that with few exceptions nearly all respondents represented different organizations: a total of 30 unique agencies can be identified based on the answers from the last survey section. Furthermore, a consistent picture emerged from the data collected: legacy systems continue to fulfill business-critical functions in government, and when replaced they significantly shape the selection, development and implementation of their successor applications.

The top reasons respondents gave for feature carryover from legacy systems were singled out to be the desire to minimize changes, end-user habit, and legislative or policy constraints. This indicates that such carryover is largely a result of internal organizational considerations and of a choice to preserve the status-quo. While this may stem from a legitimate concern over engaging too many resources in the technical migration and the accompanying business process changes, the potential benefits of a more substantial departure from the existing business model do not appear to be critically and systematically evaluated. Instead, change is perceived as disruptive and tends to be avoided.

The very label “legislative and policy mandates” suggests immutability and serves as a deterrent to change. However, as one of the subsequent interviews revealed, during a specific legacy replacement project, legislative changes were actually pursued and accomplished. This question illustrates how self-reinforcing a legacy model can be: innovations are forestalled because of existing legislation/policies; such policies have in many instances been adopted due to the state of technology at the time, but modifications to legislation to reflect newer technology changes seem too intimidating to attempt.

No specialized approach or requirements methodology for legacy system replacement was singled out from the response data. The sources of requirements which were ranked as most useful by respondents included end-user interviews, technical documentation of the legacy system and interviews with IT staff. The high utility of technical documentation is not per se an indication of the legacy problem, but it is unclear how the analysis of such documentation informs the definition of functional requirements.

When asked to explain their organization’s approach to legacy system replacement projects in their own words, survey respondents largely used procurement terminology. Standard procurement vehicles such as request for proposals, bids and solicitations, functional specifications, needs

assessment documents, and systems analysis techniques (technical evaluations, workflow analysis, etc.) are commonly used. This is at odds with the literature on wicked problems. As noted by Mallalieu et al. (1999) wicked problems are immune to resolution by applying methods similar to the System Development Life Cycle (SDLC) model (Conboy & Lang, 2011), where analysis precedes implementation, and there is an assumption of a properly-defined problem. More iterative styles of implementation, oscillating between analysis, building prototypes and evaluating them are beneficial in cases where the effects of implementing a particular technological product are uncertain. It is worth noting that only one of the respondents commented on their organization's usage of rapid application development (RAD) techniques. As noted in the literature, government procurement standards do not typically employ flexible enough mechanisms (Balter, 2011) such as pilot evaluations, agile implementation methods, etc.

The open-ended comments supplied in the survey convey a certain dependency on executive leadership and managerial style, or on specific agency-vendor relationships and political factors, as far as decision-making on legacy replacement is concerned. They also revealed disagreements and conflict over different project issues.

The majority of the respondents also singled out COTS products as their organization's preferred method of system replacement. Findings from the literature indicate that government IT practitioners believe that COTS products embed business process best practices in their software (Wagner, 2010). Such assumptions often pre-empt the need to conduct business analysis so that new or modified business processes can be defined. The options available in the COTS products are subsequently adopted and modeled after instead. However, even if a COTS product is adopted, customizations or re-configurations of it to match old features in legacy systems are still possible. Therefore, equating COTS implementation with a blank slate approach to new system adoption is not justified and further information explicating the criteria for customization and carryover during the decision process in COTS projects is necessary.

3.2.4. Threats to Validity

The survey's main limitation was the relatively low number of full responses. A higher response rate could have offered the opportunity to explore correlations between agency size, domain, jurisdiction or geographic location and agencies' legacy system replacement practices, or between particular requirements methods and the extent of legacy feature replication. Also, the respondents were primarily from the United States and the United Kingdom (possibly due to the increased participation of

practitioners from these countries in online digital government fora), so empirical insight into the legacy problem in other European bureaucracies as well as non-Western government organizations is deficient.

The low number of responses could be, however, considered in itself an important finding. In addition to the general issues with soliciting participation from working professionals, in this case the survey subject matter is seemingly narrow - a niche topic. There was no way of targeting those with experience in legacy system replacement projects in government organizations, as no such online groups, communities or mailing lists were found during the research. Additionally, while there is no indication that this was the leading cause for the low number of responses, several targeted recipients noted in personal face-to-face communications that they felt the survey might include technical questions about legacy systems, and therefore decided they were not suitable candidates to provide information. This supports the notion, corroborated by data collected through the survey, that legacy systems replacement is largely considered a technical and not a business issue.

An additional methodological issue is that participants were enlisted through self-selection. The practitioners who answered the call to

complete the survey were more likely to be individuals with either strong opinions on legacy system issues and/or those who have technical expertise in this area (Oates, 2006). Since an underlying theme of this research is that the impact of legacy IT systems over the business operations of an organization is significant, it would have been beneficial to obtain more survey responses from functional areas of organizations other than information technology. An explicit and targeted effort to ensure respondent diversity would have been warranted in order to draw more far-ranging conclusions and generalizations. As a result, the ones currently derived from the survey data can be applied primarily to Western European and North American style public sector institutions.

A further limitation with the survey is that the questions were geared towards the legacy replacement projects in respondents' agencies as a single dataset, while a more in-depth understanding could be gained when examining individual projects, their particular circumstances, project management practices and outcomes. The latter approach was adopted in the interviews, allowing for the identification of certain patterns in legacy replacement projects.

Finally, while the survey question asked directly if legacy features and models are replicated or mimicked, there might be alternative methods of evaluating this – for example, by comparing the functionality of the

previous and the new system and analyzing their similarities. Such an approach might be more accurate than a survey, as it does not rely on the subjective perceptions of individual practitioners. However, it could be feasibly employed only with a limited scope: an individual organization or several organizations within a vertical domain, and it would further rely on the exhaustive identification of all information systems and their predecessor applications. Therefore, the question posed in the survey was appropriate given the intended coverage, i.e., government organizations at any/all jurisdictional levels, from any/all regions of the world and representing any/all vertical domains.

3.3. Qualitative Interviews

The ad-hoc nature of the approach to the legacy problem, revealed through the survey responses reinforced the need for a deeper, qualitative investigation of which situations and organizational contexts are conducive to more innovative or conservative replacement efforts and greater legacy feature carryover.

Furthermore, it was not enough to identify two opposing positions during projects dealing with legacy replacement – the same attitudes are exhibited in most technology projects, as they reflect core cognitive biases that form the basis of any decision making process (Ryan, 2016). It was essential therefore to paint a richer picture: one that reveals nuances in such attitudes, including how they emerge, how they interact, and if they are consistently manifested by a type of organizational actor- with certain project roles, a particular technical background, a place in the agency hierarchy, or personality.

A small number of qualitative interviews were conducted to gain greater insight into these issues. They also provided an opportunity to start exploring the idea of introducing gamification into requirements practices.

The interviews were conducted to achieve the following general research objectives:

1) *to establish the extent to and manner in which legacy systems and business processes are reproduced in new solutions and applications*

and

2) *to capture and assess the attitudes of digital government practitioners during the planning stages of legacy replacement projects – whether aversion to risk, or propensity to innovate, or other approaches to change, and how they manifest themselves at the requirements level.*

3.3.1. Method

Semi-structured qualitative interviews were conducted as a follow-up to the survey, with the purpose of enabling practitioners to expand on the topics covered in the survey, to elaborate on the legacy problem in greater detail and in their own words, and to solicit reactions to the concept of applying a game to discuss replacement technology requirements. The interviews incorporated certain assumptions about legacy replacement projects in government organizations that were derived from the survey, namely that legacy-related projects are often contentious, that some form of business process change is almost always involved, and that external companies/consultants as COTS providers are frequently engaged in such projects.

Despite these assumptions, the interviews followed an open-ended format which allowed the participants to communicate their stories without preconceptions or impositions of any particular theoretical view concerning the interplay of technology, individual and political factors in organizations.

3.3.1.2. Interview Questions

The interview instrument was organized into three segments. In the first segment the interviewees were asked to discuss a legacy replacement project in their organization, and were posed a series of questions which covered the dynamics of this project – what stakeholders tended to disagree about, what the typical attitudes expressed were, how the discussions typically unfolded, etc. The interviews were structured in such a way that for each thematic segment there was a list of sample questions that could be asked depending on the interviewee's narrative and the particular details they shared. The sequence of the questions also differed accordingly.

During the second segment specific requirements and procurement practices were discussed. Since during the survey COTS products emerged as a preferred approach to legacy replacement, participants in the interviews were asked to elaborate on how vendors, consultants and third party companies contribute to the discussion about which features to preserve and which to phase out. Questions about how a COTS product was selected, and how requirements were put together during the procurement process were also asked.

The third segment involved sharing the idea of introducing a game to promote discussion of requirements in legacy system replacement projects

with the interviewees. As the game was at a very early conceptual stage at the time of the interviews, it was described very broadly to the participants in sentences which covered its high-level objectives and general features, specifically: ‘an online game for government staff to analyze requirements for the replacement of legacy systems, identify risks and opportunities associated with these requirements and compete/argue over which requirements are optimal.’ The interviewees were also told that in the game players would be assuming roles related to the perspectives commonly adopted in legacy system discussions (namely risk-aversion and innovation, discussed in Chapter 2). Further they were asked to comment on this play-based approach to the legacy problem, and to provide suggestions on how to design and set up the game. This line of inquiry was undertaken so that practitioner feedback could be integrated at the forefront of the game design process. The interview questionnaire is included in Appendix B.

3.3.1.3. Interview Subjects

The respondents to the survey who provided their email address were the first to be invited for an interview and two of them agreed to participate. The remaining participants were identified in the same way as the survey respondents – by posting invitations by email, on professional forums

online, etc. However, certain individuals were contacted personally as a result of recommendations and references provided by other interviewees or individuals who had completed the survey and felt that particular colleagues would provide helpful opinions due to their extensive experience.

A total of eight individuals were interviewed. Each interview was conducted for approximately 45 minutes, either at the interviewees' workplace, or at a neutral location. The interviewer took notes during the interviews and hand-recorded statements verbatim whenever possible. Audio-recordings were considered an inappropriate method of obtaining the data after several participants expressed a preference that they not be used. This is not unusual as the use of audio-recording equipment has been deemed intimidating in discussions where organizational politics are being brought up (for a review of the drawbacks of tape-recording interactions with interviewees, see Speer and Hutchby (2003)).

3.3.2. Results

The transcripts were analyzed using a general inductive approach, which seeks to isolate recurrent concepts and categories from the raw textual data, and group them in common themes (Thomas, 2006). The themes are summarized in Table 13 alongside key findings based on our research

objectives:

Table 13. Summary of Interview Themes and Their Alignment to Research Objectives

Interview Theme	Key Findings Related to Extent and Manner of Legacy Replication	Key Findings Related to Practitioner Attitudes and Their Manifestations at the Requirements Phase
<i>Executive Leadership and Power Structure</i>	Executives who are new to the agency may discourage legacy replication. Executives who delegate decision making to operational managers may be influenced to take a risk-averse approach.	The attitudes of the executives and top managers determine the replacement approach.
<i>Project Logistics/ Project Management Practices</i>	The format / level of detail in discussions surrounding requirements for replacement systems may impact the extent of legacy replication.	There is skepticism about the efficiency of current project management methods and practices to determine system replacement requirements. The current practice of managing replacement projects does not lend

		itself to creativity and collaboration.
<i>Resistance to Change vs. Enthusiasm for Change</i>	Organizations with staff with high longevity who are accustomed to working with a legacy system may be more inclined to reproduce the legacy system's model.	Some practitioners are risk averse and this enables the replication of legacy features in replacement systems. Those with more innovative attitudes promote a departure from the legacy model.
<i>Relationships with Vendors/ Consultants/ External Providers</i>	Different external providers approach legacy replication differently – some encourage innovation, others accommodate requests to replicate legacy functionality.	External providers echo the attitudes of executives and top level managers in order to implement their mandates.
<i>Business-to-IT relationships</i>	Lack of technical knowledge may discourage business users from insisting on new functionality in the systems that replace legacy applications.	In some instances IT staff encourage innovative features in the replacement systems and try to steer discussions in the direction of innovation.

These themes will be examined in detail here as they more vividly demonstrate the wickedness of the legacy problem. Two additional themes also emerged: Enterprise Consolidation and Project Participant

Personalities. While they both point to factors that can determine legacy project outcomes, they are not unique to the context of public sector agencies and will not be discussed further.

3.3.2.1. Executive Leadership and Power Structure

In the survey's open-ended comments section, participants noted that the course of legacy replacement projects depends mostly on the direction provided by upper management. Interviewees similarly indicated that key mandates or the overall spirit of a project were substantially influenced by executives (Participant ID 7). If the technology implemented was meant to consolidate operations previously decentralized across different departments, top management's directives were of critical importance. This is exemplified by the following statement: 'The CIO of [organization X] wasn't going to worry about fiefdoms and would come in and force people to play well together and be on the same page' (Participant ID 5). Another interview participant echoed this: 'The mandate to integrate came from above' (Participant ID 2).

When executive leadership is absent legacy replacement projects often experience a "stalemate," as stakeholders pursue conflicting priorities. One

interviewee described a similar situation: 'We were supposed to migrate secondary systems into the new asset management system (which was an RFP [request for proposals]), but GIS [Geographic Information System] drivers were prevailing, so we are back to square one. No one has the leverage to make a decision, and everyone is reluctant [to take responsibility]' (Participant ID 4).

In certain instances, as stated by interviewees, practitioners in government organizations have had limited views about what can be done with new technology. An outsider to the organization, who has seen different business and technology models, and whose views are not constrained by a historical perspective of the legacy systems being replaced, has been better able to steer projects in the direction of innovation: 'We have new directors coming in [to the organization] with a better attitude who have seen other systems elsewhere. The legacy system itself is not the problem for us, but the "industry" around it is' (Participant ID 1).

3.3.2.2. Project Logistics/Project Management Practices

A recurring theme in all interviews was the mechanics of gathering and analyzing requirements, or discussing current and targeted practices.

Project management practices are an important factor, as meeting format (Jarzabkowski & Seidl, 2008; Romano & Nunamaker, 2001), end-user

engagement, or stakeholder identification (Pardo & Scholl, 2002), and participation rules can often determine project outcomes (Participant ID 8). As the interviewees revealed, discussion and analysis sessions are often time-consuming, and their attendees with different levels of influence in the organization. This tends to skew the resulting decisions and analysis in favor of the position of those with the most seniority, rather than producing an objective analysis of business process issues. Two interviewees recounted such episodes: 'When we implemented [software X] we sat there for 7-8 months in fit-gap meetings reviewing every custom in the system, what [department Y] was using, what [department Z] was using. These were long drawn out meetings, it was worth it but we have the Project Manager in there, and if they don't use it [the current system] daily all they do is ask "Do we need this or that, or not?"' (Participant ID 5), and 'The requirements meetings were a 6 hour single session, not a productive format, some people didn't speak up. Our IT project management was to blame. A good breakdown [of the process|system|requirements] would have been strategic' (Participant ID 2).

An additional obstacle to productive requirements sessions was revealed to be the discussion's level of detail. An overview of the selected technology that was too high-level was not conducive to the identification

of organizational issues and needs. When companies present their software products, they might struggle to properly define the granularity of the detail they are reviewing with either the line-of-business or the IT staff in their government agency customers: “There was an as-is vs. to-be session, which was vendor-heavy and organized by the IT project manager. The session followed a vendor-provided template. Subject Matter Experts just explained their process, with a focus on exception scenarios. The drawbacks of this process were that the demos of [software company - name deleted] were high level and were not geared towards public utilities specifically. The business people hadn’t touched it [the software] or “kicked it around” (Participant ID 2).

3.3.2.3. Resistance to Change vs. Enthusiasm for Change

It is important to note that during the interviews it was revealed that legacy systems don’t always have interest groups that overtly push for their de-facto replication, or for adherence to the status-quo. Legacy systems drawbacks have often resulted in staff clamoring for change, because the system usage has been so burdensome: ‘I sat with the employees who used the [old] forms and asked ‘How much is this form chewing up from your day?’ It was all done in Crystal [reports]. The guy who did them retired... this was “great”!...so now nobody could modify the report. For them to change a name of an attorney for example, it would

take 2 weeks. It was like the request was going into a black hole. We needed to wait until IT could do it.' (Participant ID 5)

At the other extreme, those who have achieved a mastery of the legacy system intricacies, or have successfully developed workarounds through other applications, may feel marginalized when the legacy system is replaced, and therefore put forward certain features of the legacy system as essential requirements (Participant ID 8). The story of an employee responsible for printing and mailing utility bills highlights the importance of engaging those who are deeply involved with the old process in the planning and implementation of replacement systems. Participant 3 recounted: 'People don't like change and they are good at what they do. Staff were concerned... e.g. they were coming from [the perspective] of mechanical inserts – we sent people cards, and the guy who did it was good at decollating and carbon copy. Now he had to start using a computer. He used to take the bills to the post office. We just took it one step at a time ("How do you eat an elephant"). You just need to make them [people|staff] feel better. The comments about the new system being worse came from people who least used it.'

In many organizations legacy systems are poorly documented, with

business rules often available only in the form of legacy system code (Gupta & Bhatia, 2005; Kardasis et al., 1998). As it became clear from the interviews, during legacy replacement the project participants who convey the rationale for these undocumented rules have typically been involved in implementing and maintaining the legacy system in the past, and they are providing a historical frame of reference to the business processes in the organization (Participant ID 7). The narrative surrounding "historical reasons" often served as a deterrent to a critical investigation of whether business process change was merited, because project participants would assume that IT systems and the workflows they support had "evolved" into their most feasible state and cannot change any further. "Historical bias" emerged as a topic during the interviews: 'Often they say "it didn't work like that a long time ago". The only knowledge we have is someone's opinion from years ago. And I have seen directors walk out of meetings due to conflicts [resulting from this attitude]' and 'Old and antiquated users are people with long memories who only remember the bad things' (Participant ID 1).

3.3.2.4. Relationships with Vendors/ Consultants/ External Providers

A varied picture of how organizations and external technology providers interact during legacy replacement projects appeared. In some cases, the consultant/vendor took an innovative approach, promoting business process transformations, and in others the consultant/vendor encouraged

(perhaps unnecessary) customizations to replicate legacy systems features, rules and workflows. One of the interviewees gave this example: 'Another big issue/variable was that the vendor was providing the solution, and kept saying "Hey, we can customize it!" which opened the door to these unnecessary changes, and to more money being spent. A couple of SMEs have a lot of power over there and [the vendor] took advantage of that. There wasn't much change of the business process in the end other than the use of the tool. They [the vendor] listened to what the business did, took the requirements down, didn't look at [potential] business process change, didn't say "couldn't we try this?" - it was a literal translation' (Participant ID 2).

3.3.2.5. Business-to-IT Relations

As noted previously, legacy systems tend to be perceived mostly as a problem for the IT department, as it is often technology-specific triggers that spur their replacement (e.g. end of life announcements, incompatibility with newer hardware platforms, etc.). However, the embeddedness of these systems in business operations has led IT to increasingly involve representatives of the business operations side in the replacement process. The interviewees' statements and recollections demonstrate that the extent to which the discussions, analysis and

decisions taken in legacy replacement projects incorporate the business perspective differs across organizations and projects.

Whereas the survey results indicated that legacy replacement projects tend to be IT-dominated, the qualitative interviews drew a more nuanced picture of the IT department's role, where IT staff seeks to enable and assist the business side and offer, in the words of an interviewee "a change-friendly mantra". One of the participants (Participant ID 1) in the interviews described what he saw as a substantial role evolution: 'IT in the past 15-20 years used to be like this "here is a product, now work this way with it". The pendulum has swung, now IT asks "what is your problem? But we can only do it [develop the right solution] if we are a part of the discussion [with the suppliers]. Training in business processes, and not IT is needed because we need to look at technology as "business systems"'. Participant 6 described a similar role reversal: 'In [our organization] we didn't have IT push the project, it was pushed from the business perspective.'

3.3.2.6. Requirements Game Feedback

A consistently positive and enthusiastic reaction was registered when the idea of a game-based tool for requirements discussion was referenced during the interviews. Participant ID 6 remarked that the very notion of a

game is inviting: 'When it is a game, people will want to get involved.'

Another interviewee (Participant ID 2) acknowledged that if the game medium is online, it will allow more people to voice their opinions, and for arguments to get more easily across, since during meetings people interrupt each other and often not everyone has an opportunity to speak: 'If there was such a game, I may have been able to explain some points I couldn't get across during the [requirements] meeting.' And even as the game concept generated excitement in and of itself, interviewees acknowledged that the game must ultimately have on-the-job utility: 'But you have to look at how it will benefit people in their jobs. E.g. how is it going to add to your evaluation... The best would be if they can say 'it made my job easier'' (Participant ID 6). Also, that it could potentially be used in lieu of some traditional project management activities: 'we sat there for 7-8 months in fit-gap meetings reviewing every custom in the system - these were long drawn-out meetings' (Participant ID 5). In suggesting such a pivotal function for the game, the same interviewee cautioned that the game should not seem too light and "frivolous" in terms of its content and aesthetics: 'you need to be careful that it doesn't look too un-businesslike (with too much levity).'

To echo the notion of a simulated and anonymous environment being more

liberating for practitioners (referenced in Section 2.9), all interviewees stated that anonymity during the game would be the preferred approach. In one interview, a statement was made that ‘the concept of safe haven is great – a place without threat of public challenge’ (Participant ID 1). However, the interviewee highlighted that there are drawbacks of anonymity, and of poorly designed anonymity as well: ‘core people would know [recognize] each other, then it could turn into a hostile environment, and you will lose the enthusiasm if that happens.’ According to another statement ‘anonymity goes against our culture of accountability, but if the subject was a high-tension one (e.g. related to vendor selection) I would have preferred to be anonymous’ (Participant ID 2). Finally, anonymity was seen as a potential problem when recognizing game participation and input: ‘anonymity is both a plus and a minus. Supervisors need to have to have a way of gauging your contribution’ (Participant ID 6).

There was no dearth of ideas from the interview participants on how to design the game and make it engaging: as Lucas Blair remarked during his conference talk at Serious Play 2016, designing a game and coming up with its features is often more educational and entertaining than playing the game itself (Blair, 2016). The interviewees stated that badges and reaching higher levels within the game (“rank promotions,” as one interviewee called them) are good extrinsic motivators. According to one statement, modeling the game after popular gamified applications and game platforms

might be beneficial: 'giving people a sense of achieving a goal, getting somewhere, will be good - just like building up the levels in Candy Crush, or in Four Square with badges. It is important to see something being built, like SimCity' (Participant ID 1). This interviewee's suggestions focused on organizing the game to be in tune with project management and software development practices: 'Steps in the game can be -1) requirements 2) debate 3) conclusion 4) sign-off, and after sign-off this [visually] becomes a house, then a block (like rows building themselves up in a city). It is important for the player to see that he built something, get a sense of achievement of having something delivered. You can also go into scoring how beneficial certain requirements are.' In a similar vein, another interviewee proposed that 'the innovator concept can be separated out as an idea team and a build team' (Participant ID 2). To align the discussion along the themes of risk and organizational impact a recommendation was voiced to allow the players to 'rank the risks against the probability of things happening. Someone at a macro level needs to create these weights looking from an enterprise perspective. There need to be qualitative aspects as well.'

In regard to the introduction of player roles in the game, two interviewees proposed the use of personality assessment instruments to achieve a good

fit between the game persona and the participant's character: 'we went through color spectrum training, which defines your personality. It gives you an idea of what is the best way to communicate with different types of people,' and similarly: 'we had a system to evaluate personalities, where they were asking some questions and they determined the types of personalities [of public servants]. There were 3 types – positive proactive/pleaser, individualist, and one in the middle (not sure). Having the negative people in a virtual room is helpful' (Participant ID 1). As a counter-argument to the typification of users into permanent roles in the game, other viewpoints were communicated as well, namely the possibility of playing multiple roles or roles opposite of one's natural inclinations: 'I may want different roles at different times. A lot of risk-averse people might become innovators in a gamified context, since they break out of their immediate work culture,' and 'role reversal in the game is a good idea. People surprise themselves about what they can do' (Participant ID 4).

3.3.3. Interview Findings Synopsis

While the practitioners revealed nuanced opinions on the subjects discussed during the interviews, some key points were made consistently. These can be summarized as follows:

- 1) Project management approach matters to the outcomes of legacy replacement projects, specifically: the way requirements are initially

defined, how they are distributed, who is invited to meetings for their discussion, who moderates the discussion, who prioritizes them, etc.

2) Organizational position of project participants also matters: the approach management and executives want to adopt determines the overall direction of the project, and their presence in requirements discussion meetings may discourage participation and stifle honest discussion.

3) The risk aversion attitude could be motivated by different factors, such as fear of diminishing an employee's current role or influence; biased risk/impact analysis which assigns operational disorder a higher probability; fear of bad publicity; lack of creativity in how change can be implemented to mitigate disruption.

3.3.4. Threats to Validity

Similar to the survey, the qualitative interview portion of our research suffered from a paucity of participants. While the goal of qualitative research is not to achieve generalisability of its findings but to explore in detail the perceptions, attitudes and opinions of those involved in organizational phenomena, a larger number of interviews with subjects representing a more diverse set of government agencies would have

enabled a more comprehensive investigation into the legacy problem and how it is dealt with in the public sector.

In addition, while all measures were taken to ensure impartial presentation of the topic studied and of the goals of this dissertation, the face-to-face interaction of the interviewees with the researcher always bears the risk of skewing the reporting, or wording of certain issues to conform with what practitioners have decided the interviewer is interested in hearing. These general methodological risks notwithstanding, the interviewees, being experienced government professionals, largely did not shy away from voicing controversial opinions and being honest about failures, missteps as well as successes during legacy system replacement projects.

3.4. Analysis of Consolidated Findings

The online survey and interviews set out to uncover how practitioners perceive the impacts of legacy systems on their agencies and how they define the requirements for applications intended to replace legacy technology. While the National Audit Office (2013) report identifies legacy systems as a risk to government organizations, in the survey, the questions about the impact of legacy technologies to agencies' operations were posed in more neutral terms, offering respondents the opportunities to describe the benefits of legacy systems in addition to their disadvantages. According

to the survey results and interview data, and in contrast to the NAO report, the move away from legacy systems is seen as a risk in and of itself. This is an important distinction, as a different approach will be adopted when a project is undertaken to mitigate risk than when a project is deemed to be itself a risk. The legacy problem manifests itself more explicitly in the latter case, hence the focus on how practitioners define and perceive the role of the legacy system in their organization.

Government organizations, which cover multiple jurisdictions, functional and geographic areas, continue to deal with challenges stemming from the usage of legacy systems for the support of business critical operations.

Moreover, for fear of operational destabilization, project managers and IT practitioners are willing to mimic the functionality of these systems during their replacement in order to minimize changes. Furthermore, the survey data demonstrates that legacy replacement projects are driven by IT specialists, even where business process analysis is concerned. During the interviews, it was confirmed that the project managers for replacement projects are either themselves IT staff or have an IT background.

Special attention was paid to the requirements phase of legacy replacement projects since this is when determinations of the essential

features of legacy systems are usually made. According to the survey and interview data, how requirements for the replacement of legacy systems are handled by practitioners in the public sector depends on a combination of both macro-level factors, such as enterprise strategy, executive direction, funding, or trends in the IT product market, and micro-level factors, such as personal interrelationships, preferences and attitudes. The interviews confirmed findings in the literature that often decisions are taken at the executive level and the requirements analysis is conducted after the fact, and in a way as to conform to said decisions (Kamal et al., 2010). Business analysis is not singled out as a separate step or activity in such projects, but is often coupled with other project activities which may cause IT considerations to be conflated with business considerations.

Adherence to either risk aversion or to a more innovative stance is not rigidly divided by IT versus business lines. There are proponents of both attitudes in either organizational area. While this was difficult to ascertain through the survey responses alone, the analysis of practitioner interviews revealed that the approaches of IT staff towards innovation and preservation of old business process are flexible, and they often advocate change.

In the online survey, respondents were asked to describe the processes and techniques they utilize in legacy replacement projects both from pre-

defined responses and as free-form comments. The interview data is closely aligned with the free-form comments, revealing disenchantment with traditional project methods and practices, including planning, analysis and requirements sessions. These methods are often formal in terms of "ceremony" (Meyer et al., 1977), but not objective enough to produce an impartial evaluation and to secure stakeholder consensus. A case can be made that tools and approaches specific to legacy systems replacement projects might be beneficial, and that they should promote creative thinking, so project participants can develop and assess alternative business process scenarios rather than uncritically extend a legacy model.

Another important finding is the preference to implement COTS products as a replacement for legacy systems. All interview participants had experience with such projects. According to their statements, when COTS products were implemented and customized, the discussion was framed by the vendor or technology provider and an analysis of the risks and benefits of innovating business processes was rarely performed explicitly. The approach adopted often during such projects was to follow the path of least resistance, with focus on making the current process fit in the new system with minimal work. A picture emerged from the interviews of government staff too preoccupied with logistical issues – meetings, documentation,

policies and rules, and perpetually involved in developing workarounds to technological, organizational, and legislative constraints, to focus on the big picture during their analysis.

Resistance to change was a given in legacy replacement projects, however it was not always overtly expressed as such. The drive to preserve the organizational status quo can often be manifested as the carryover of legacy system features perceived as essential and too risky to modify. In such instances, the wickedness of the legacy problem is revealed in the uncritical acceptance of the existing work model in the organization, and the reduction of the legacy system replacement effort to a back-end technical migration, which is ideally transparent to the business users.

Given the complex nature of legacy projects, interviewees expressed support for the idea of introducing a game that encourages discussion of requirements for replacement systems. They were emphatic that the design of the game must accommodate concerns about free expression of ideas in the organization, well-targeted participation incentives and must ultimately help those involved in it to perform their jobs better.

3.5. Chapter 3 Summary

The research detailed and discussed in this chapter demonstrates that government agencies continue to rely on legacy systems for their daily operations and dedicate substantial resources to their maintenance and upkeep. Such systems not only have technical limitations, but they impede public organizations' ability for business change. When legacy systems are phased out, their features often become the business requirements for the software meant to replace them. This is problematic because opportunities for process improvement and organizational innovation are being missed. Furthermore, despite the adherence to formal procedure and highly-structured bureaucratic processes in government, respondents' agencies handle legacy systems replacement largely in an ad-hoc manner, with a preference for the acquisition of COTS products, which results in the de-facto outsourcing of the analysis associated with the replacement effort to vendors and consultants. A significant level of carryover of legacy system features into their replacement software occurs, mainly in order to minimize changes to business operations. Coupled with the finding that such projects are either spearheaded or dominated by IT staff, a conclusion can be reached that a persistent mantra in the project management of legacy systems replacement is to transition to new technology leaving the business operations as-is, and worry about its re-engineering later on.

While industry and academic literature have primarily focused on the technical challenges associated with legacy systems, this research indicates that in government agencies it is the organizational culture and work process challenges associated with legacy replacement that are more pronounced. The wickedness of the legacy problem was revealed in the project stories shared by practitioners: the intertwining of technology, people and political issues defies traditional IT-centric project management approaches. Even when a technology is replaced, the legacy work model persists, and its imprint, often the result of resistance to change and risk-averse attitudes, impedes government organizations from achieving transformations which will improve the services they deliver to the public.

The feedback from the interviews regarding the suitability of a game-based approach to address the legacy problem, and of its main features of anonymity and a debate/dialectic dynamic, enabled the research to progress to the first iteration in the game design, described in Chapter 4.

Finally, in terms of methodological issues, it should be noted that even in the age of the internet, with all the networking opportunities this creates (e.g. virtual communities of interest and practice, LinkedIn, Facebook, etc.), research of the kind reported here still proves challenging, resource-heavy

in terms of time and commitment, and ultimately producing a more limited quantity of data than anticipated.

Chapter 4: Primary Research - The Design and Development of a Requirements Game

As outlined in Section 1.3.4 (Chapter 1), employing a game to enable a structured discussion of requirements along the themes of risk aversion (legacy preservation) and innovation is considered a potentially effective technique to address the legacy problem. This chapter introduces the design (Section 4.3) of the initial version of the game - PROVO - and its theoretical underpinnings (Section 4.2), as well as the initial evaluations undertaken with government practitioners to review its early version (Section 4.5.), and inform a subsequent design iteration. The findings from the initial evaluations led to design modifications (Table 14) and to a second version of the game – RE-PROVO (described in Section 4.7) – which determined the technical parameters for prototype development described in Chapter 5.

4.1. Research Objective

After establishing the dimensions of the legacy problem through quantitative and qualitative empirical studies, the final research objective of the dissertation was to evaluate the introduction of a game as a means of assisting the requirements analysis phase of legacy replacement projects by promoting greater practitioner engagement and creativity. This objective (defined in Chapter 1) underlies our motivation to not only

analyse the legacy problem but to cautiously venture into design and development research by seeking out and proposing appropriate “antidotes” to routine risk aversion. Probing deeper into practitioner attitudes through a qualitative investigation of practitioners’ project experience resulted in valuable information about their individual motivations and about large-scale environmental determinants. However, it was unclear how these attitudes, feelings or concerns can be engaged or challenged to produce a meaningful and productive discussion around legacy system replacement requirements. A more actionable model was needed to this effect.

4.2. Theoretical Foundation of the Game

At the beginning of this research step it was undecided whether the game concept would evolve into a full-fledged immersive game or would become something similar to a requirements-focused tool superimposed with a gamification layer. In order to determine the most suitable strategy, we reviewed different models of conducting requirements analysis and various discussion tools/formats. Ultimately Potts et al.’s Inquiry Cycle and Maiden et al.’s creativity workshops (more specifically the roleplay exercises employed during them) formed the theoretical basis of our game.

We also looked into already existing requirements –focused games and their potential application to legacy system replacement projects .

Games have been employed in the requirements engineering domain to educate students (Alexander & Beatty 2008) and practitioners on requirements engineering concepts such as prioritizing requirements (“Buy a Feature”), creating a balanced product roadmap (“Prune the Product Tree”) (Ghanbari et al., 2015), and on useful techniques for collecting innovative requirements, e.g., SECONDS and refQuest (Zarvić et al. 2009). Some of them employ basic role-playing (Zapata & Awad, 2007), while others involve the re-enacting of hypothetical project management scenarios which teams must collectively resolve. Also noteworthy - *EPMCreate* (Mich et al., 2005) is a creativity-enabling technique which allows requirements analysts to look at a problem from a different combination of users’ viewpoints; as such it exhibits some relevance to the legacy problem in its attempt to reconcile opposing perspectives.

While these are examples of games and practices successfully applied to requirements activities, none of them included all the game characteristics that would help address legacy issues. *EPMCreate*, for instance, supplements techniques for elicitation, while the game being created as part of this research focuses on the analysis and validation of already

defined requirements and on conflict resolution around them. The games and creativity exercises reviewed did not offer general prescriptions for the design of requirements-focused games. Hence, none of these examples could be applied directly to the context of the legacy problem.

A number of researchers in academia and industry lament the lack of serious game design frameworks (Seager et al., 2011). This is due to the fact that serious games is an umbrella term that includes games in numerous domains, hence needing to reflect the best practices of many disciplinary traditions (Khaled & Ingram, 2012). As a result, serious games design heavily mimics the design practices of mainstream game design, where the starting point for the creation of a game is a designer-defined metaphor or concept (Khaled & Ingram, 2012). The concept adopted by this research is based on Potts et al. (1994)'s Inquiry Cycle Model, made more actionable, interactive and engaging through the addition of game actions and incentives, and inspired by creativity workshop roleplay (Maiden et al., 2004). The game design process was informed by the triadic game design framework (Harteveld, 2011). We briefly recall several of these influences here (a more thorough overview was given in Chapter 2), and introduce triadic game design in detail.

4.2.1. Inquiry Cycle Model

When requirements are derived from a legacy system, it is important to specifically analyze their linkage and similarities to the legacy system features, and seek justifications for their mimicking in the new system. Therefore, an inquiry process wherein a requirement is subjected to a deliberate challenge of its source (the legacy system) and rationale (e.g. the minimization of risk and change) appears to be a suitable approach to tackle the legacy problem. The Potts et al., (1994)'s Inquiry Cycle Model offers concepts to support such an analysis and argumentation process. It defines an inquiry-driven cycle, where the concept of challenge involves scrutinizing a requirement: one must answer questions regarding the need for the requirement in its current form and the reasoning behind it must be made explicit. This forms the basis of discussion, after which a decision can be reached as to whether and how the requirement should be modified.

The decision to gamify the inquiry cycle is driven by the need to encourage competition between the legacy and innovation perspectives and to ensure that participants respond actively to the challenges by producing alternative requirements modifications. Game elements such as rules and roles are defined to facilitate these actions and mitigate the risk that the discussion may not follow the prescribed themes or reach meaningful outcomes.

4.2.2. Triadic Game Design

The non-domain specific triadic game framework (Harteveld, 2011) supported the design process, and its principles were used as high level design goals. Triadic game design distinguishes between three main areas: ontological, semiotic and ludic (Harteveld, 2011). The ontological aspects of a game encompass the underlying model of the real-world domain the game is based on. The semiotic design incorporates the elements and approaches that make the game meaningful and generate lessons and useful information that can be transferred to the “real-world”. The ludic aspects refer to the techniques by which a game is made interactive, challenging, fun and immersive. Well-designed games achieve a balance between these elements: without a strong ontological base, a game would be simplistic and suitable for basic education only; without the semiotic emphasis, the game would be mostly fun but not educational; and without the ludic elements, the game would be merely a training or simulation tool (Martens et al., 2008).

With the triadic game design principles in mind, a basic mapping between game elements, requirements engineering concepts and organizational goals was developed. It was essential to introduce game elements purposefully, and to associate them with learning or pragmatic outcomes.

This mapping aims to assist in the evaluation of the utility of individual ludic concepts first at the design phase of the game concept, and next at the stage of assessing a functional game prototype. The mapping will be presented in Subsection 5.5.4. after an overview of all game elements.

4.2.3. Creativity Workshops

Another format of discussion which is complementary to the inquiry-based model are the creativity workshops described and carried out by Maiden et al. (2004), which we evaluated, among others, as a potential mechanism to target the legacy problem.

The key technique borrowed from Maiden et al. is roleplay. Since games create an artificial, fictional setting, participants often assume different roles, characters, or personas that allow them to explore a diverse set of behaviors and assumptions, and take symbolic actions. As a result of the dis-inhibition effect of roleplay, the personal barriers that usually hinder participation in group discussions and collective activities should be reduced (Aubusson et al., 1997).

Maiden et al. utilize a set of roles defined originally by Von Oech (1986), to enable practitioners to channel their creative energies while performing requirements engineering activities. In this research, the game purpose is

analogous to the creativity workshops in that it should encourage participants to think beyond the status quo and the processes that are taken for granted, by exploring alternative perspectives.

Another goal of the creativity workshops is to open up the solution space by encouraging out-of-the-box thinking and to enable participants to communicate their opinions more freely by allowing them to voice any frustration or dissatisfaction they might be experiencing. This is another similarity our game shares with such workshops: it strives to be a “safe space” for competition and opposition, as it is well accepted if a person is competitive during gameplay, whereas in any other workplace situation conflict is generally avoided. Furthermore, evidence from early evaluations of group-based decision support systems indicates that a critical tone in ideation exercises is more effective for the generation of creative ideas than a supportive one (Connolly et al., 1990).

4.3. Requirements Game Synopsis

Ultimately, our game became a competitive requirements “discussion forum” where requirements are critiqued from the two dominant perspectives in legacy system replacement projects – risk aversion and

innovation. The game was meant to be played before business requirements are delivered to a vendor, or service provider via a procurement document such as a call for tenders, request for proposals, or invitation to bid. In the case of bespoke development, the game should be played prior to commencing development efforts – i.e. before a finalized requirements specification is delivered to the software development team. In an agile development environment the game can be executed in parallel with the iterations or “sprints” taking place, and it can be consulted by product owners to finalize the formulation of user stories.

While it was ideally designed for primary participation by business users, information technology staff or users with a technical background can also partake, as long as the discussion of technical details does not dominate the gameplay.

The basic principles of gameplay are as follows. The business requirements that have been already defined for an application replacing a government legacy system are entered one by one as separate discussion threads in an online repository. Each player is assigned to be either a Heritage Keeper, or an Innovator. The players need to review the requirements. Those in the role of Heritage Keeper must issue a challenge to the requirements they think depart too much from the operational status-quo and are too risky for implementation. Those in the role of Innovator must issue challenges to

the requirements which too faithfully reproduce legacy workflows and features, and thus do not take advantage of new technologies to streamline operations. Once a requirement has been challenged, any player can respond to the challenge by proposing a modification to the requirement, i.e. by “morphing” it in way that addresses the issues put forth in the challenge. The morphings can be challenged too, thus potentially producing several different versions of a requirement. At the end of an agreed upon timeframe (e.g. two weeks), the players vote on all the proposed requirement morphings, and those with the most votes become the winning versions of the requirements. The players are awarded points based on their activity and engagement – they are recognized for each challenge, morphing, comment, or requirement rating they make. The player with the most points becomes the winner of the game. Descriptions and illustrations of the final game features are included in Section 5.1.2.

The game was meant to focus the participants’ discussion around the legacy and innovation viewpoints specifically, and it does this by assigning players the respective roles of Heritage Keeper and Innovator. Before deciding on the ultimate mechanism to achieve such focus, we put the game through several design reviews, and playtest iterations. The evolution of the game from its initial version (called PROVO) to its final

state (labeled “RE-PROVO”) is detailed in the following sections. Revealing this evolution aims to demonstrate the method of game design, the validation, or invalidation of our design choices, and the important insights into the legacy problem which were gained in the process of obtaining practitioner feedback.

4.4. PROVO: Proof of Concept Design

At the core of our game design approach was a direct mapping of the key concepts established by Potts et al. to ludic elements (or game activities) and player roles inspired by Maiden’s creativity workshops. Functional requirements from previous or current IT projects in government agencies were used as the ontological basis of the game.

The main premise of the game is that of the requirement challenge: a player questions a particular requirement and others must either modify or justify the requirement. Hence, the name of the initial version of the game - PROVO – which means test or attempt in the international language Esperanto.

The following Inquiry Cycle elements are employed in PROVO as game elements and actions:

- 1) requirements documentation – the collection of proposed requirements used as a starting point,
- 2) challenges – questioning the rationale of a requirement,
- 3) answers (to challenges) – proposed changes (morphings) of the requirements,
- 4) reasons – justifications for a requirement original or modified versions.

Borrowing from the Inquiry Cycle terminology, in PROVO a challenge is essentially a request to change a requirement or to justify its original form. Challenges are what is categorized as conflict elements in game design (Fullerton, 2014), as they invoke reactive or defensive behavior from a player's opponent in the game.

"Morphing" a requirement in PROVO is equivalent to Potts et al.'s answer, i.e., the modification of the requirement as a result of a challenge. This is the game ultimate objective, as generating alternatives to the initial requirement should hypothetically promote creativity and a departure from legacy-driven formulations.

4.4.1. *PROVO: Game Goals*

PROVO aims to support creativity by enabling individuals to participate in a roleplaying activity with well-defined rules. According to the “structuralist” approach to creativity, innovative solutions often emerge as a result of exercises in which one has limited courses of action and has to work within constraints (Ocker, 2010). In the game, the players are asked to respond to specific challenges and to morph requirements according to pre-defined risk and innovation-related criteria. Since PROVO features an element of competition with others, it also enables creativity along the principles of the “situationalist” school (Shneiderman, 2007), i.e., by establishing a social/group environment where rewards and recognition are offered. The game participants are given the ability to comment, support or reject morphings, with the visibility of feedback and the encouragement of critique seen as fostering creative outcomes.

4.4.2. *PROVO: Game Context*

The requirements used during a PROVO game session are derived from real legacy system replacement projects taking place in government agencies, hence the players are familiar with the domain, and the system which is at the center of the game is not imaginary. This satisfies the triadic game design stipulation for faithfulness to the real world (the ontological dimension of the triad). All requirements are listed for everyone to see from the beginning of the game and players in various roles can challenge and comment on them in no particular order.

Players participate anonymously and asynchronously in PROVO. The online medium makes anonymity possible, and this is beneficial where workplace hierarchies or other factors tend to stifle open discussion (Ocker, 2010). For instance, if a project stakeholder in a senior position feels strongly about the particular requirements for a new system, their rationale may not be questioned and their preferences may be implemented due to their seniority in the organization (such situations were described in the qualitative interviews analyzed in Chapter 3). In a truly anonymous space, idea generation is more effective since ideas cannot be traced back to specific individuals (Cooper et al., 1998). Furthermore, some studies have determined that anonymous idea

submission platforms are more successful if more participants are involved, possibly because the participants do not feel inhibited to propose a greater number of ideas (Dennis & Williams, 2007). Finally, online availability and asynchronous participation in the game are required to enable offsite communications (Ghanbari et al., 2015), since some players may not be allowed to use their work hours to participate in the game.

4.4.3. PROVO: Game Roles

Similar to Potts et al.'s approach, PROVO aims to promote exploratory thought during the requirements phase. PROVO's purpose is also analogous to the creativity workshops in that by exploring alternative perspectives it encourages participants to think beyond the status quo and organizational processes that are taken for granted. In addition, through more concretely defined roles, the game is designed to target the legacy problem specifically.

In the game players must take on one of the following personas: "heritage keeper", "innovator", "arbiter" or "problem-solver". PROVO's design is based on the actions of two main players – the innovator and the heritage keeper, who both issue challenges towards specific business requirements. The term heritage was adopted to avoid the potentially negative associations which tend to accompany "legacy" (Brooke & Ramage, 2001).

The heritage keeper approximates to Maiden's judge role, while the innovator maps loosely to the artist. Incidentally, the heritage keeper also maps to the 'Black Hat' (the hat of judgment and caution) in the Six Thinking Hats Technique (De Bono, 1999), and the Innovator, to a combination of the Yellow Hat (brightness and optimism) and the Green Hat (creativity, alternatives and new ideas).

The innovator identifies those requirements which replicate the old system's features unnecessarily, and issues individual challenges to each such requirement stating the reasons for the challenge. The heritage keeper must also issue challenges: they can state that a particular requirement introduces too much of a departure from the status quo and this may therefore introduce business risk.

The other players in the game, the problem solvers, respond to these challenges by either morphing a requirement to meet a challenge of their choosing, or by providing justifications as to why a requirement should remain unchanged. Another player, in the role of arbiter, decides if a challenge is met based and moves the requirement to either an Innovation or to a Heritage space (the concept of spaces will be described in the next section), where it is no longer subject to change. The introduction of an

arbiter is based on the third-party approach to conflict resolution suggested by Khaled & Ingram (2012). A requirement can also be assigned to a Neutral space, if it cannot meaningfully be challenged or morphed along legacy preservation or innovation lines.

4.4.4. PROVO: Game Dynamics

The innovator and heritage keeper review the listed requirements. They each issue challenges to selected requirements, in which they identify legacy-preservation or innovation issues. The heritage keeper will challenge requirements which are too innovative and risk organizational destabilization, and the innovator will challenge those requirements which overwhelmingly emulate legacy systems and processes.

Problem-solvers respond to the challenges posted by suggesting a re-formulation of the requirement which addresses either the innovator's or the heritage keeper's critiques. Each problem solver can select which challenge to respond to. Any requirement re-formulations can also in turn be challenged by the innovator or heritage keeper.

To assist with requirement classification in legacy problem terms, the notion of a "space" is introduced. If a requirement morphing successfully addresses a challenge, the arbiter can place the requirement in either the

Innovation space or the Heritage space, thus removing it from future rounds of the game. A Neutral space is utilized as well: it is intended for requirements which cannot be discussed from the perspective of legacy feature replication. The game ends when all requirements have been assigned to a space. Whether the innovator or the heritage keeper wins is determined from the number of requirements they manage to get assigned to their respective space.

Table 13 below maps game elements to requirements engineering concepts and organizational outcomes based on the triadic design framework. The ontological concepts are borrowed from the official curriculum of the International Requirement Engineering Board (IREB) as documented in *Requirements Engineering Fundamentals* (Pohl & Rupp, 2011). The intent of the mapping is to demonstrate how a game component (in the “Ludic Element” column) approximates or simulates a requirements engineering concept (under “Ontological Elements”), and to highlight an activity or skill which could potentially be employed or affected as a result of engaging in the roleplay, game moves or actions, i.e., this the area where a ‘meaningful effect beyond the game experience can be intentionally achieved’ (Kortmann & Harteveld, 2009).

Table 14. PROVO Game Elements (based on the Triadic Design Framework)

Ludic Element	Ontological Elements	Semiotic Elements
Challenge	Requirement Analysis, Conflict Identification	Critical reasoning
Morphing	Requirement Change	Combinatorial or transformational creativity
Innovator	Stakeholder, Creativity Techniques	Business process design
Heritage Keeper	Stakeholder, System Archaeology, Requirements Reuse	Risk assessment
Problem-Solver	Requirement Analyst/Engineer	Business analysis
Arbiter	Project Manager, Requirement Negotiation, Requirement prioritization	Decision-making
Spaces	Requirement Categorization, Requirements models	Product Architecture

4.5. Proof of Concept Game Review

Multiple game design review activities were planned from the outset of the PROVO game development effort. This is in observance of iterative principles of design and creation research as well as software development methodologies, such as Agile (Highsmith & Fowler, 2001), and of game design methodologies of playable prototypes that can be tested immediately (Wagner & Wernbacher, 2013). An initial round of playtesting to try out the different game roles and their interactions was organized with a small group of practitioners from a government communications department. As a next step, before the commencement of a technical effort to implement the game in an online environment, a visual prototype of the game was created and presented for discussion at a focus group session with public administration students.

4.5.1. PROVO: Playtesting

Playtesting is a recommended practice for testing the viability of a game concept (Chaffin & Barnes, 2010) and for further evolving a game design, which must be carried out continuously and iteratively in order to ensure that the game ultimately functions as intended (Fullerton, 2014). It involves simply playing the game, regardless of whether all elements or technologies are already in place or finalized. In fact, it is recommended

that playtesting be carried out as early as possible even within an imperfect technological environment. Best practice in game design dictates that multiple revisions to a game model will be necessary for the delivery of an optimal player experience (Fullerton, 2014).

The first playtesting session involved a low fidelity try-out of the game conducted with a team of non-technical business experts at a municipal government agency in the United States. The purpose was to evaluate PROVO basic roles, rules and dynamics for their adequacy in discussing requirements in legacy system replacement projects. The session was intended to imitate the flow of the game using a generic online communications tool, without a specifically developed graphical user-interface.

4.5.1.1. Playtesting Procedures

The playtest involved five participants –heritage keeper, innovator and three problem solvers. The innovator and the heritage keeper would issue challenges to ten sample requirements for a new web portal application for citizens, intended to replace an old municipal website.

The arbiter was intentionally not assigned as part of the playtest so that the natural propensities of the players could be observed. The assessment of

the initial game concept focused on the heritage keeper, innovator and problem-solver roles and did not rely on the arbiter's intervention for enforcement of the game rules. As it is possible that an arbiter could dominate the discussion, if the individual in this role is naturally assertive or has a dominant role in the organization, any issues related to the definition of the other roles may not come to the forefront.

The players were gathered face-to-face prior to the playtest and PROVO basic rules and concepts were explained. All roles were assigned randomly with the exception of the heritage keeper, who was assigned to an individual who identified with that role. The problem solvers' role was to respond to challenges by proposing either mitigations to requirements deemed risky or modifications to requirements that were not considered innovative. The game was carried out as a web conference (a WebeEx meeting) during which each player participated from their own office and typed challenges or responses to challenges in a common chat window, while ten sample requirements were displayed as a numbered list in the background on the screen. Each participant typed in the number of the requirement they were referring to and then their suggestions for modification or justification. Participants had to define their own screen name and most selected screen names that did not reveal their identity,

with only the heritage keeper player choosing a screen name that revealed their identity.

The web conference session was programmed for 45 minutes. After it ended it was discovered that due to some technical issues the innovator player could not log in and participate. None of the other participants were aware of this due to the option for anonymous participation. The problem solvers were essentially responding only to the challenges of the heritage keeper, who gave general feedback on the requirements rather than address risk specifically, and also made some suggestions on morphing the requirements. All players participated actively and expressed their opinions about each of the 10 requirements.

4.5.1.2. Analysis of Outcomes

During the playtest it became evident that the players did not follow their prescribed roles, as they made broad and diverse comments which were not necessarily aligned to innovation or risk issues. The arbiter role would have been important in this context as this role is responsible for adherence to the game rules. Alternatively, or to mitigate against disproportionate influence by an arbiter, automated mechanisms to effect observance of certain rules would have to be implemented.

With the defined set of roles a minimum of six players are needed to ensure adequate role distribution (a heritage keeper, an innovator, three problem solvers and an arbiter) and such a level of participation may be difficult to achieve at all times. The heritage keeper and innovator roles possess significant control over the game's flow, as without their challenges a requirement may not become subject to discussion. Additionally, a sufficient number of problem solvers might be impossible to find as the individuals in this role would ideally be both objective and knowledgeable enough to propose modifications and justifications without bias.

Another observation from the playtest is that an asynchronous mode of play, i.e., allowing players to log in whenever they want within a predetermined general time span such as days or weeks, may be problematic: the competitive dynamics may not emerge if some players, more specifically the heritage keeper, the innovator or the arbiter, are absent and cannot therefore respond to or initiate actions. As already noted, during the playtest session the innovator did not log in for the game duration and in that timeframe a lot of comments and suggestions were made. Should the innovator had been present, the problem solvers may have made different comments, because the innovator and the heritage

keeper might have issued different challenges in response to each other's actions. Furthermore, the importance of a visual structure in the exchange of comments was underscored. If the participants had done this exercise within a well-structured game interface and not a plain chat window, it would have been easy to identify that the innovator's input was missing, as threads would have formed visually for each requirement, thus better enabling a structured dialog. Furthermore, since there were no visual cues such as approvals, rankings and/or "thumbs up" for the comments of the problem solvers, the element of competition was downplayed and the feedback ended up being somewhat general and non-interactive.

4.5.2. PROVO: Screen Design Focus Group

The need for a properly designed graphical user interface was emphasized during playtesting, hence a focus group session was conducted to obtain feedback on the preliminary visualizations of the game flow of PROVO represented as screen mockups (see Appendix C). The objective of the focus group session was to present the game's roles, rules and goals to the participants through a series of static screenshots, and to solicit their thoughts on what issues may arise during gameplay with the current game design, and what could make the game more engaging. The participants could not actually playtest the game, as a working online prototype was not yet built.

4.5.2.1. Focus Group Procedures

The session participants were 18 students from an urban planning course, which was part of a graduate studies program in Public Administration in South Florida (henceforth, here and in Section 4.5.2.2. the terms “participants” and “students” will be used interchangeably). The students were working professionals, some of whom were at the time employed in the public sector. The session was carried out over an hour and 30 minutes and was structured in the following way.

Participants were asked to complete a short anonymous questionnaire about their attitude towards risk (Appendix D). The questionnaire was modeled on similar tools used in the financial industry to create risk profiles for investors. The purpose of the questionnaire was to provide a general understanding of the group’s propensity towards risk in professional projects and to be used as contextual information when analyzing their feedback on PROVO. Additionally, there was intent to “test-drive” the questionnaire in order to determine if it could be used as part of the team assignment mechanism of the game in later trials: risk-takers could be assigned an innovator role, and those who are risk-averse could

become heritage keepers. However, in utilizing the risk profiling instrument there was a chance that the questions and responses format could result in a risk-neutral profile – i.e., one that shows neither a predisposition towards taking risks, nor towards conservative and safe behaviors, and this possibility also needed to be evaluated. After the participants completed the questionnaire they were given a short overview of the legacy problem as defined by this research and the purpose of the game within that context.

Next, students were given a description of an IT system project carried out previously by a County government organization in South Florida. This was to ensure that the requirements used in the gameplay session were based on a specific, real-world project: the replacement of a multi-agency business registration process with a novel consolidated online system.

The session participants were guided through a hypothetical gameplay session illustrated in seven screen mock-ups:

- 1) team assignment based on risk questionnaire responses,
- 2) requirement list screen,
- 3) issuing a challenge to a requirement,
- 4) showing a requirement “chain” listing all challenges and responses to these challenges under a single specific requirement,

- 5) challenge dashboard - a visualization of all the challenges issued by one team,
- 6) requirement voting screen,
- 7) leaderboard - a listing of the players with the most points and successful challenges.

The presentation of the screen mockups was interactive. The students participating in the session asked questions, made suggestions and commented both as the screen mockups were being shown and after the presentation concluded.

4.5.2.2. Analysis of Outcomes

Most students agreed that the PROVO game was an innovative approach with great merit, but they had many questions about the game's prospective organizational implementation. The students' inquiries and comments primarily covered the proposed logistics around the game, and there was less interest in discussing the graphical user interface presented in the screen mockups. They made specific recommendations in three general areas:

1) Anonymity

Focus group participants felt very strongly that the game would not be successful if it was not anonymous. They were concerned that there might be ways in which management might obtain the identities of the players and see the comments and recommendations they made. They highlighted the need to assure game players of the absolute safety and freedom of expression that the game would afford, so that they could be honest in their suggestions and analysis. Students also asked how the final requirements developed throughout a game session would be communicated to decision-makers in the organization where PROVO is used. It was vitally important to them that both the privacy of those involved is preserved and that their recommendations are considered seriously as possible changes or improvements.

2) Participation Incentives

How to reward participation was a key theme during the focus group session, with students demonstrating concern that without proper rewards employees would not take their engagement in the game seriously. According to the focus group, elements inherent in the game such as points, leaderboards and votes, would work only in conjunction with more tangible, real world rewards, like organizational recognition, or perhaps paid time off from work. However, such incentives may be difficult to provide if players are to be kept strictly anonymous.

3) Player Selection

Students expressed the view that it was very important to identify which employees would be the most appropriate participants in the game. For example, some individuals may be either aggressive or disruptive when disagreement arises, and some may lack first-hand knowledge of the subject area covered in the project, so they may not be able to contribute substantially to the discussion. The students also raised the question of whether the public should be invited/allowed to play, and suggestions were made about engaging citizens when a project involving an externally facing system is being discussed. Several session participants felt that any ranking, marking as “favorite”, up-voting or down-voting, of requirements should be opened up to the public, unlike the actual challenge-and-response discussion features themselves, because ensuring constructive participation may not be easily manageable in the case of fully open access. Additionally, one participant’s view was that members of the public may not demonstrate sustained involvement in online activities that require ‘more than three steps’: this view echoes the standard web usability recommendation that no web content be more than three clicks steps from the main page of a site (Zeldman, 2001).

The data analysis of the risk profiling questionnaire did not reveal a preponderance of either profile in the group, and there were also no profiles which were completely neutral.

The students in the focus group surprisingly provided less feedback on the graphical user interface of PROVO than on organizational dynamics and participant characteristics. Such organizational focus was also an indication that details regarding the game elements might be less important than the conversation and discourse surrounding how the game is executed in a government agency environment.

4.6. Discussion and Implications for Game Redesign

The participants in the playtest session and focus group felt that the proposed game-based approach to tackling the legacy problem was promising and creative. Their reactions to the gameplay experience and to the initial game design were positive. However, they expressed opinions and suggestions on how the game could be made more effective for the organization where it might be utilized, and more engaging for its players. A number of design implications were derived to address the shortcomings discovered during playtesting, and to satisfy the concerns expressed in the focus group session.

In the area of game mechanics, the need to adjust the game roles to minimize complexity and promote adherence to innovation and heritage themes became evident. In the playtest, problem-solvers did not have sufficient incentives to produce requirement morphings. Additionally, all players had a hard time abiding by the themes of heritage preservation or innovation: their requirement critiques and comments covered a variety of themes, and even their personal requirement preferences. The heritage keeper also engaged in actual requirement modification proposals, thus overstepping into the actions of the problem-solvers. These issues may have been ameliorated by the involvement of an arbiter, however, the extent of these role variations indicates that while attempting to maintain proper game procedure, the arbiter has an opportunity to exercise a disproportionately dominant role compared to the other players. Selecting a suitable individual for this role from the government organization where the game is played may not be feasible, or possible. Therefore, a decision was made to remove both the problem-solver and arbiter roles from future iterations of the game.

In the area of organizational setup for gameplay sessions, the need to ensure player anonymity was highlighted as critical for the provision of unrestrained, creative feedback. This differs from the setup of Maiden et

al.'s creativity workshops, which are physical gatherings of individuals, and from the recommendation of one of the practitioners interviewed as part of the qualitative study (described in Chapter 3), who suggested employees play the game as part of an offsite group retreat.

In order to remove any potential bias or difficulties with role assignment, it would be preferable to automate this process. The roles would be granted to players by the game software itself, potentially after the participants answer personality questions, which assess their propensity towards novelty, their resistance to change and other traits relevant to the problems of risk aversion and legacy preservation in organizations. The use of the risk assessment questionnaire would therefore be continued in the planned game prototype design and evaluation sessions.

In the area of visual game elements, a need emerged to include improved visualizations to structure dialogue, and allow players to more easily track previous game actions, with the goal of supporting asynchronous play. In the initial playtesting session the sequence of challenges and their resulting morphs was unclear due to the mixed order of chat messages. Also, the focus group session highlighted the need to incentivize engagement - there is a pronounced need for multiple visual feedback cues about player progress and status. With this concern in mind, the removal of the space concept would simplify the presentation of requirement discussion chains

and the respective feedback for each requirement challenge and morphing. The space notion was initially designed to end the cycle of requirement morphings and to effectively “freeze” a requirement, so it could be counted as a “point” for either the heritage keeper or innovator. With multiple feedback options such as “favoriting,” ranking or voting, space assignment would not be necessary. Therefore, a design decision was made to eliminate the space element from the game.

A need to enable the game to be carried out with minimal involvement and intervention from an organizational coordinator, or technical administrator additionally emerged. To evaluate objectively whether a game-based approach is effective in requirements practices around legacy systems replacement, a fairly self-contained game that participants can step into and engage with after minimal involvement from an outside party is essential. The elimination of the arbiter role and the automation of role assignment would contribute substantially toward achieving this goal.

4.7. RE-PROVO: Game Modifications

The PROVO evaluation in the preceding sections revealed that the initial design needed to be re-examined and fine-tuned to make the rules more

easily understood and enacted, and simplify the rollout in actual workplaces. Table 12 summarizes all the design changes made to PROVO features in the RE-PROVO version of the game and their justifications: these are discussed in greater detail from Section 4.7.1 onwards.

Table 15. Design changes in RE-PROVO

PROVO Feature/Rule	RE-PROVO Modification	Justification
Arbiter decides on successful challenges and allocates morphings to spaces	Eliminate arbiter	It is difficult to identify an individual who is impartial to the innovation and legacy perspectives, and can be objective. This role has disproportionate power over the outcome of the game.
Only innovator and heritage keeper can issue challenges	Allow everyone to issue challenges	More players need the ability to critique a requirement via the challenge mechanism so that the innovation and heritage perspectives can be actively employed. If a player feels that a requirement can be improved, they do not have to rely on the pre-existence of a challenge, but can issue the challenge themselves.
Morphings are assigned to spaces	Eliminate spaces	The discussion cycle does not need to be formally closed for any requirement – better versions of the requirement can always be developed. This modification is also related to the elimination of the arbiter role.
Either the heritage keeper or the innovator wins	Enable competition between all individual players	Problem-solvers do not have sufficient incentive to produce meaningful morphings. Individual competition will provide incentives for all players, with more challenges and more

		morphings being issued.
Problem solvers create morphings	Enable morphing for all players	During playtesting the heritage keeper engaged in making morphing suggestions. There is no need to artificially disallow some players from making such suggestions, and this may lead to more requirement modifications.
Morphings are assigned to spaces	Winning requirement are established via voting	This modification is the result of the elimination of the arbiter role. It also allows players to follow their natural inclination towards either perspective through voting.

4.7.1. RE-PROVO: Simplified Role Schema

The previous chapter revealed that the initial PROVO design contained role and action complexities which confused the players and resulted in a less than smooth experience. The initial role scheme envisioned a heritage keeper and an innovator, whose function was solely to formulate and issue challenges to the requirements they deemed in need of modification. The task of modifying the requirements themselves was supposed to be carried out by multiple players in the problem-solver role: players who are not formally aligned to the heritage keeper or the innovator and are supposed to focus only on the morphings they propose without exhibiting bias towards either perspective. However, during playtesting most players did

not take the actions prescribed by their roles, so a simplification of the model was deemed necessary.

The modification made in RE-PROVO was to allow all players to be either in the innovator or the heritage keeper role so that anyone can issue challenges and respond to them by creating a requirement morphing. This helps all the players to be directly engaged with either the innovation or legacy perspectives, and for no role to have disproportionate power over determining which morphing is well-formulated and satisfies a challenge. This is contrary to the initial PROVO design which dictated that decisions about whether a requirement morphing satisfies its challenge was within the purview of the arbiter. PROVO essentially modeled the arbiter after the game master role in traditional tabletop Role-Playing Games (RPGs): the game master's scope of control and power is the *entire game environment*, which includes defining the narrative of the game and ensuring observance of its rules (Arjoranta, 2011). The game master also has the ability to critique individual players' behavior if it is not deemed appropriate. In many RPGs this has been seen as excessive –a “godlike ability to ignore or bend the rules,” and the game master's role is frequently dissolved, with its responsibilities distributed amongst the other players (Mäkelä et al., 2005). What this implies for PROVO is that the arbiter may skew the game in favor of either the heritage perspective or the innovation perspective, or even a third perspective (related to a specific project) with no bearing on the

legacy problem. In PROVO, the heritage keeper and innovator define challenges that the problem solvers cannot diverge from in their proposed morphings, and the arbiter ultimately decides on their quality: the problem-solvers are in effect powerless, yet the requirement morphing cycle relies heavily on their proposals for requirement modifications.

In order to make informed decisions about which challenge is satisfied the arbiter needs to be impartial, well-versed in business analysis, with extensive knowledge of the organization and the system under consideration. The selection of such an individual would be difficult, as they may not be available to participate in the game or, in some cases, they simply may not exist in the organization. In RPGs players could express their disagreement with a game master by not participating in the games they design and moderate. However, in an organizational setting such behavior may lead to organizational conflict, which is contrary to PROVO's intention not to aggravate existing disagreements or spur new ones outside of the game environment. When playtesting the game in a chat client, most if not all of the issues encountered were the result of the lack of an arbiter who would remind the players of their responsibilities. This indicated that there was an overreliance on the arbiter role in the initial design – it was based on an individual-driven conflict resolution model which depends on

the personality of the arbiter. An arbiter could be friendly and largely unobtrusive or brusque and conflict-prone, yet an organizational game should ideally have a neutral resolution system (Mäkelä et al., 2005).

Based on the analysis of the current balance of power in the initial version of the game, the arbiter and problem-solver roles were eliminated. In RE-PROVO a player is either an innovator or a heritage keeper. Depending on their role, users have access to different game actions: innovators, for instance, can issue “innovation challenges,” while heritage keepers, “heritage challenges.”

Additionally, as a result of the role modifications, the concept of spaces and assignment of winning requirement morphings to a space became unnecessary. A new mechanism for scoring requirement versions had to be developed that allowed for the determination of a winning morphing by the players themselves, and not through external means or actors. The focus group session (discussed in Section 4.5.2.) elicited multiple suggestions for feedback mechanisms such as voting, marking as “favorite”, or ranking. The design challenge RE-PROVO needed to address therefore was how to meaningfully determine the most successful morphings, while avoiding “stalemate” situations in which players vote on or support only the requirement modifications produced by players who are like them. It was decided to focus on an individual competition scheme rather than

introducing formal teams for players who may share roles. If the focus is on individual competition, each player must adopt a strategy where the morphings they create attract more votes and more quality rankings. In the individual competition scheme it doesn't benefit a player's own overall ranking if they vote for a morphing created by someone in the same role as theirs. Therefore, a decision was made in RE-PROVO to leave the dynamics of gameplay open and not to integrate rules that are conducive or prohibitive to team collaboration, but to observe if patterns of team actions naturally emerged.

4.7.2. RE-PROVO: Player Assignment

Questionnaires are commonly used in serious games to ensure a better fit between players learning styles, gaming styles or other personal traits and their roles in a game (Sancho et al., 2009). Based on recommendations by two public sector practitioners interviewed as part of the qualitative study reported in Chapter 3, Section 3.3.2.6. , a risk analysis questionnaire was designed to allocate roles to players: players with a risk-averse predisposition would be allocated the heritage keeper role, while risk-takers would be given the innovator role. An open question is whether allocating the opposite role in order to allow for the exploration of an alternative perspective, and the development of an empathetic stance,

would be a better strategy. It was decided that in RE-PROVO this would be observed during the game evaluation sessions and inquired into with the participants when their feedback was gathered afterwards.

4.7.3. RE-PROVO: Requirement Morphing Cycle

The main object of debate in RE-PROVO is the “requirement” as a textual description of a proposed system feature. Requirements are pre-entered by the game administrator, but users also have the option of adding their own requirements. Once a requirement is created, it is marked as being in its “initial” version and players can issue a challenge to it. When a challenge is issued, the player must state the reasons the requirement is being critiqued – in the implementation, either by a free-form comment or by selecting one out of a pre-defined list of issues that matches items elicited in the survey described in Chapter 3 and Appendix A. More specifically, reasons were derived from the question ‘Which issues that could potentially occur during legacy system replacement projects is your organization most concerned about?’ Two lists were then produced. For innovation challenges, the reasons were:

- Staff must be re-trained;
- More staff members will be needed;
- Requires change to standard operating procedures;
- May introduce operational instability/confusion;
- Requires a change to staff’s roles and responsibilities; and

- May result in data loss/data migration issues.

For heritage challenges, they were:

- Doesn't take advantage of new technology;
- Too time-consuming;
- Reproduces old/inefficient workflow; Introduces inconvenience to end users.
- Re-using the categories from the survey was intended to assist players with the formulation of the challenges and as guidance on what type of issues one can look for in a requirement.

After a requirement is challenged, its status changes to “challenged”.

Once a challenge is posted, players can respond to it by re-framing the initial requirement. All players have access to a “requirement morphing” action and must specify a new definition for the requirement that addresses the challenge posed. Once a morphing has been created, the status of the challenge object is changed to “morphed”. A requirement morphing can also be challenged, as it is considered a full-fledged requirement.

Players can comment on any requirement. The comments do not constitute a challenge, hence should not offer a re-formulation of the requirement. Instead they are intended for asking questions, listing resource material

such as links, and for other auxiliary purposes. During playtesting the participants were issuing challenges which included generic commentary on the requirement. The comment feature was enabled so that players do not use the challenge action for any other purpose but to critique the requirement from a legacy or innovation standpoint.

A summary view illustrating the requirement morphing cycle in RE-PROVO is presented in Figure 2.

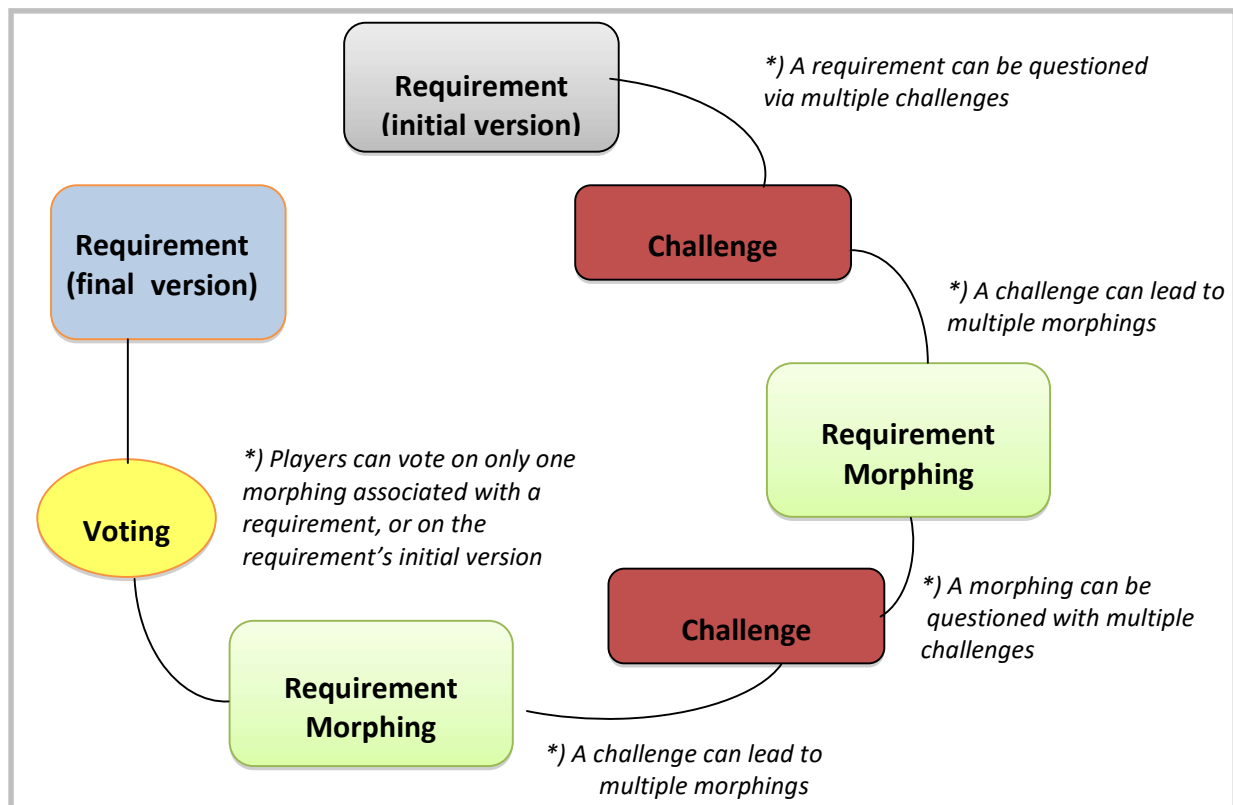


Figure 2. RE-PROVO Requirement Morphing Cycle

4.7.4. RE-PROVO: Feedback Actions

As previously indicated, players can vote anonymously to elicit a winner. This practice is consistent with idea management solutions where ideas are being “crowdsourced” and voted on by employees or by the public (Majchrzak & Malhotra, 2013). Votes can be given to either a requirement or to a morphing, and the vote represents what the player believes is the version of the requirement that should ultimately be implemented. This method of determining a winning requirement is necessary in the absence of the arbiter role and its function of assigning a morphing to either the heritage or innovation spaces.

A rating option also exists, which allows all players to give a “star ranking” to any game object (requirement, challenge or morphing) as a general indication of their support for or agreement with it. This was implemented so that players can evaluate requirements and morphings through other means than voting, as voting is meant solely to elicit a winner. Additionally, challenges themselves may have different levels of quality due to the actions of the players. Thus, some challenges can be more frivolous, and issued just to accumulate activity points (points are described in the next section), while others may be well thought out. According to a statement from one of the qualitative interviews (Chapter 3, Section 3.3.2.6.) people

need to see reactions to their game actions throughout multiple features. The rating feature was implemented as a way of providing such feedback to the players.

4.7.5. RE-PROVO: Points and Badges

Players accumulate points and badges for their activity. This practice is a standard mechanism in gamification to reward players for both overall engagement and for specific behaviors (Zichermann & Cunningham, 2011; Fullerton, 2014; Deterding, 2012). Points are awarded when a player issues a challenge, creates a requirement morphing, comments on a requirement, challenge or morphing, creates a new requirement, ranks or votes on any object. Badges are awarded either for consistent actions (e.g. for creating mostly morphs, or for numerous comments), or when specific point levels are reached.

A player's main goal in RE-PROVO is to generate the winning requirement morphings, as this results in more points than any other game action. For this purpose, players must also issue multiple challenges since without challenges morphings cannot be created. Therefore, challenge generation is essential for the morphing cycle of a requirement to begin. In attempting to mimic the Potts et al.'s Inquiry Cycle, the game ultimate goal is to establish

at least one discussion iteration for each requirement, i.e. to ensure that a morphing cycle has commenced with a challenge and is “closed” with a proposed morphing, or answer.

4.8. Chapter 4 Summary

A proof-of-concept requirements engineering game focused on addressing legacy system feature replication issues was defined based on the Potts et al.’s Inquiry Cycle model, Maiden et al.’s creativity workshops and informed by triadic game design principles. The game’s initial version, labeled PROVO, involved: players in innovator and heritage keeper roles challenging requirements established for the replaced of a legacy system; problem solver roles modifying the requirements to address the challenges posed; and arbiter roles deciding if a challenge was met. This game concept was put to test through a low-tech playtesting session and a focus group discussion. Based on these two separate evaluations, adjustments were made to the game design and a second design iteration was initiated (named RE-PROVO). The game role scheme was simplified and the rules amended to support selection of winning requirement formulations by the players themselves. The technical implementation and user evaluation of RE-PROVO are discussed in the next chapter

Chapter 5: Primary Research - RE-PROVO Game

Implementation and Practitioner Evaluations

This chapter details and the prototype implementation of the requirements game, re-branded as RE-PROVO, and modified as the result of the playtesting and focus group outcomes covered in Chapter 4. In particular, it presents key features of its technical implementation (Section 5.1). It then describes two separate RE-PROVO evaluation sessions (Section 5.2), carried out with practitioners from public agencies in South Florida, and analyzes their outcomes (Section 5.3) by reviewing observations, data points and feedback from the participants. The chapter concludes with a critical summary (Section 5.4).

5.1. RE-PROVO Prototype Technical Implementation

In order to provide a complete play experience and be properly evaluated, a paper prototype was not deemed sufficient and the game needed to be implemented as fully functional software which could be accessed online and experienced by multiple players. When planning the RE-PROVO implementation, the first task involved matching the game purpose and scope to a suitable platform that could accommodate all its critical design features. Traditional gaming platforms are more suitable for action-based games that do not primarily involve textual discussion, but feature quests

or missions with tasks like acquiring objects or defeating an opponent in combat. In contrast, RE-PROVO is similar to dialogue-based serious games, for which, however, there is a dearth of platforms as they typically require a domain-specific model (Khaled & Ingram, 2012). Also, RE-PROVO is not a simulation tool where players use avatars to re-enact actions from their everyday environment in a virtual setting, so Second Life (Second Life, 2017) or similar immersive environments could not be re-purposed. Finally, the alternative of developing the game as a custom application was not feasible due to the time constraints of the research, and also because the game implementation was not the end-product, but rather a vehicle to validate the game approach to tackling the legacy problem.

A key principle of RE-PROVO is anonymous participation, hence the game had to be made available online. Also, in order to accommodate the busy working environment of the government employees who would utilize it, asynchronous participation was required. With these requirements in mind, three types of software platforms were evaluated for the RE-PROVO implementation: idea crowdsourcing, employee feedback management, and Agile, Lean or Kanban (Stellman & Greene, 2014) project management platforms. These types of platforms were deemed to match the game model, namely one that encourages ideation, creativity and discussions in

the format of point-counterpoint.

The first choice for evaluation was the MMOWGLI platform, utilized by the Naval Postgraduate School for crowdsourcing of ideas to solve complex global problems. MMOWGLI stands for Massive Multiplayer Online War Game Leveraging the Internet. The game utilizes cards as reactions to ideas, aggregates activity points, and lists most active players on a leaderboard. The cards are also organized in chains to more easily track the discussion and progression of an idea. After a significant customization effort, MMOWGLI was rejected due to lack of developer support.

Employee feedback and idea management tools were then considered. These aim at inviting and discussing workplace ideas from employees and are typically integrated with gamification components in order to encourage engagement. The tools reviewed were all based on proprietary software and their licensing was cost-prohibitive, hence they were discarded.

Finally, traditional project management and issue tracking software platforms were examined. This category of software already embeds a model of discussion and management around IT-related work items, such as tickets for customizations, reported bugs or user stories in the style of the Agile development approach (Highsmith & Fowler, 2001), hence they

were deemed a suitable underlying platform for RE-PROVO. In particular, using an issue tracker would allow for alignment of the game to the ontological requirements of the Triadic Game Design framework, i.e., the game would be more faithful to the reality of project management activities in the organization by emulating steps, processes and concepts akin to those in software development and systems maintenance projects. Among them, the JIRA platform was selected, which will be discussed next.

5.1.1. Prototype Platform Selection and Customisation

The JIRA platform (Atlassian, 2017) was selected for the implementation of RE-PROVO due to its flexibility of customization and the level of technical support offered by its development community. JIRA can track different types of units of work - issues, software bugs, feature requests, agile stories, project tasks, and enable various workflows for their resolution. As JIRA's core function is issue tracking, the main programmatic object in it is the "issue." JIRA allows for different actions to be taken in response to an identified issue and automatically enables changes to the issue status through a workflow transition process. It has utilities for commenting, prioritization, grouping and categorization – all operations that are relevant and germane to requirements-related activities. Nonetheless, the software did not support the challenge-morphing cycle envisioned for RE-

PROVO: no action similar to a challenge was available and no options for modifying an issue, while keeping track of its versions or evolution, are present by default in the JIRA issue tracking model.

To develop such capabilities, a series of additional plugins developed by third-party companies were installed, so that an issue could be reconfigured to approximate the main RE-PROVO game elements – initial requirements, challenges and morphings. These add-ons were used to customize programmatically the following critical features, either through client-side scripts, variable or parameter changes in JIRA's administrative settings, or via modifications to configuration files:

- 1) creating a link between a requirement, a challenge and a morphing;
- 2) rating a requirement, challenge or morphing;
- 3) providing a graphic visualization of a requirement discussion chain;
- 4) providing a nested representation of requirements, challenges and morphings in a spreadsheet format;
- 5) assignment of points, badges and game characters; and
- 6) automatically assigning statuses to requirements and challenges.

The full list of JIRA reconfigurations and plugins is available in Appendix E.

5.1.2. Prototype Core Features

Some of the RE-PROVO core features are briefly illustrated in this section with sample screenshots of the graphical user interface.

A requirement (Figure 3) has the following components – main text, current status, a rating widget, a section for comments, a voting option, a linkage visualization area and an action menu that allows for issuing challenges.

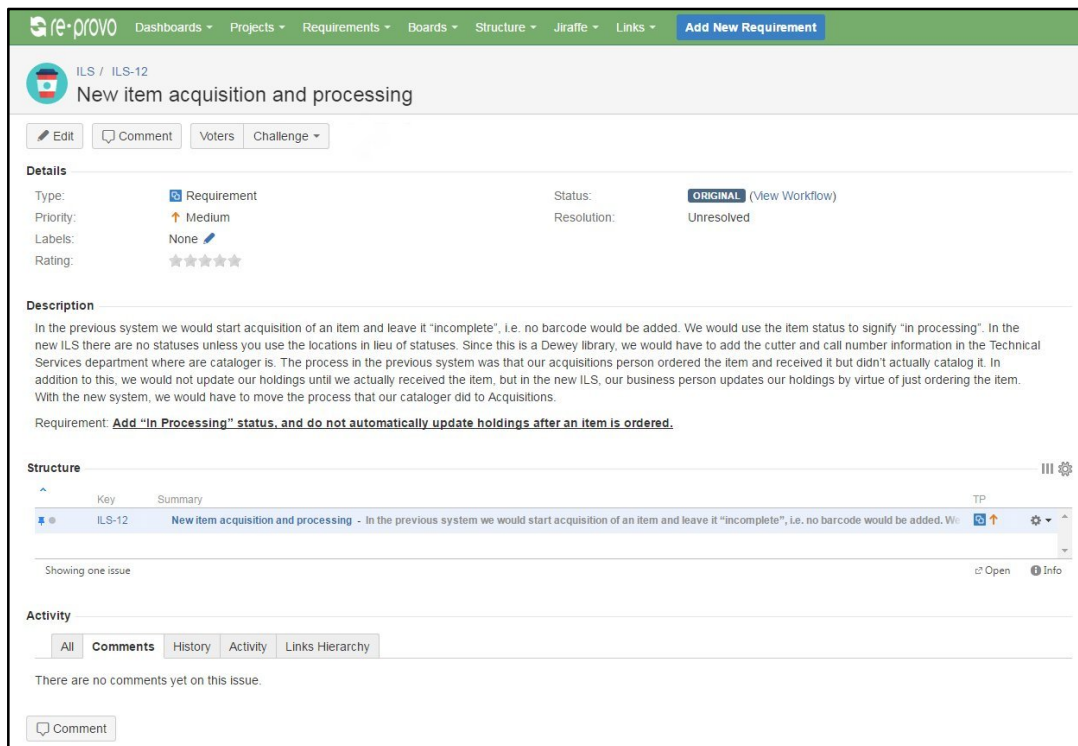


Figure 3. RE-PROVO Requirement Screen

The players issue a challenge by selecting an option from the Challenge Menu (Figure 4). The players are then required to specify the reason for the challenge and to select an issue category.

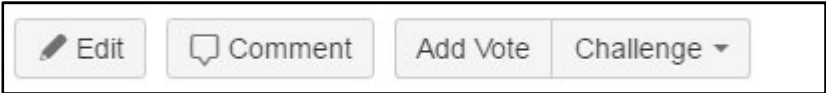


Figure 4. RE-PROVO Challenge Menu

Figure 5. RE-PROVO Challenge Screen

When players respond to a challenge they select the Requirement Morphing option in the Challenge menu (Figure 6). A morphing (Figure 7) requires the specification of a new requirement formulation.

ILS / ILS-15

Heritage Challenge to Requirement: Inter-Library Loan login with FB account

[Edit](#)
[Comment](#)
[Add Vote](#)
[Challenge](#)

Details

- Voters
- Requirement Morphing
- Labels
- Delete

Type:
 Status: **ORIGINAL** (View Workflow)

Priority:
 Resolution: Unresolved

Labels:

Congratulations:

The user who issued this challenge was granted 100 points! Check the [Jiraffe link](#) to see the leaderboard.

Problems with Requirement: Requires change to standard operating procedures, May introduce operational instability/confusion

Rating: ★★★★★

Requirement Morphing

Project: **ILS**

Issue Type: **Morphing**

Summary: **Morph based on: Heritage Challenge 10414**

Description:

Style **B** **I** **U** **A** **%A** **Link**

Describe what you are changing the original requirement to:

Reporter: **assia.alexandrova@gmail.com**

Priority: **High**

Resolution: **In Discussion**

Rating: ★★★★★

Clone Options

[Create](#) [Cancel](#)

Figure 7. RE-PROVO Morphing Screen

The requirement discussion chain (which challenges are issued for which requirement, and which morphings respond to which challenge) can be

visualized as a “links hierarchy” (Figure 8). This satisfies the suggestion from the focus group and playtesting sessions that requirements versions are more easily traceable.

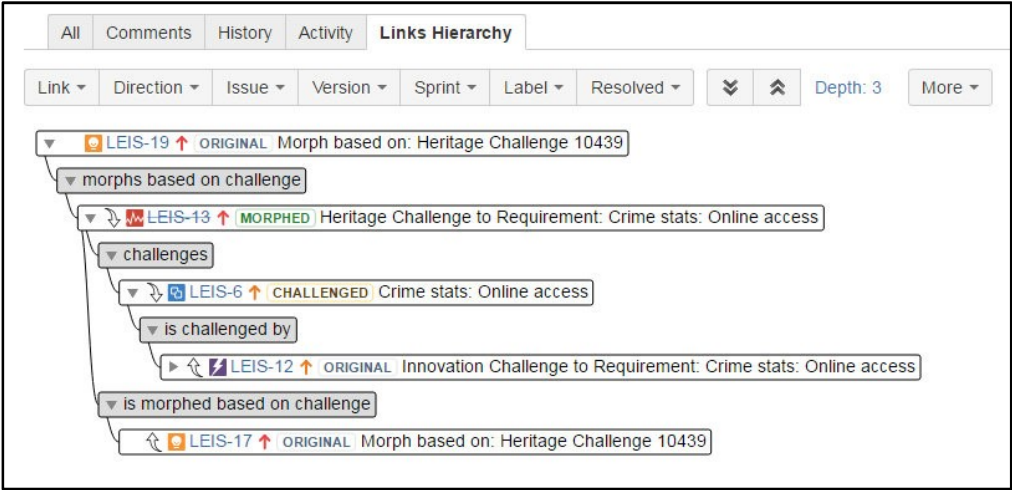


Figure 8. RE-PROVO Discussion Change Visualization

The players access the points, leaderboards or badges in the Jiraffe tab (Figure 9) of the interface, where Jiraffe (Bug Potion, 2017) is a third-party add-on for gamifying the JIRA platform, visually based on a pirate theme. Additionally, an alert message is displayed after a challenge is issued, or a morphing created to notify players that points have been awarded.

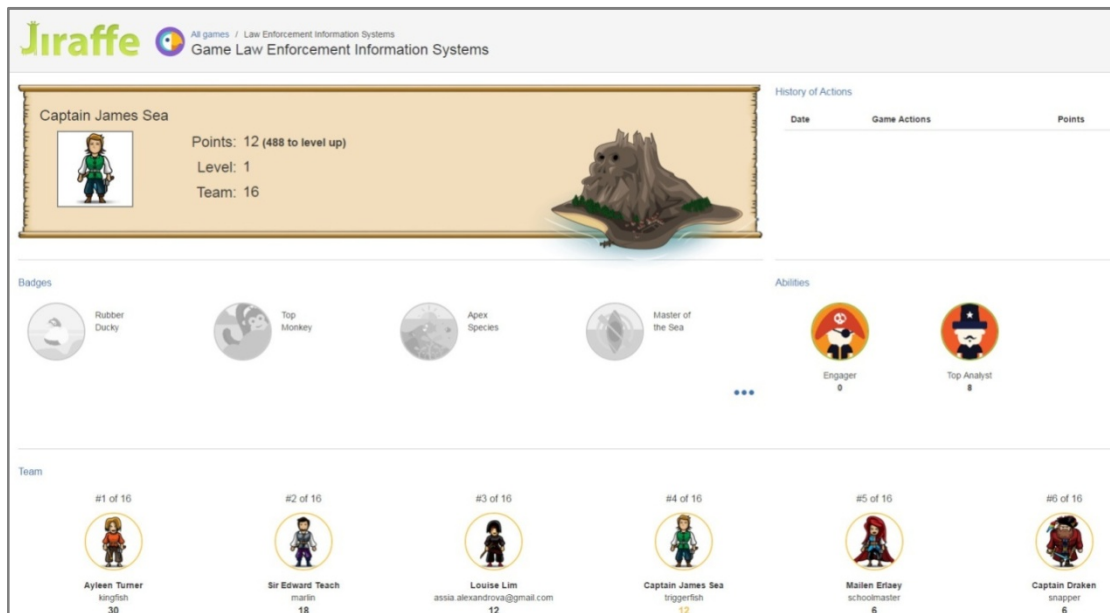


Figure 9. RE-PROVO Leaderboard

Role assignment (Figure 10) is made by the RE-PROVO administrator.

Users are added to the system with an email address, then associated with a role and added to a user group, so that all respective permissions for interface actions and visualizations are automatically set.

Snapper Schoolmaster	schoolmaster email3@fortlauderdale.gov	Count: 6 Last: Today 6:06 PM	jira-software-users Support	JIRA Software
Vermillion Snapper	snapper email4@fortlauderdale.gov	Count: 6 Last: 01/Aug/16 9:57 AM	Developers jira-software-users	JIRA Software
Gray Triggerfish	triggerfish email5@fortlauderdale.gov	Count: 4 Last: Today 5:47 PM	Developers jira-software-users	JIRA Software
Saltwater Tripletail	tripletail email6@fortlauderdale.gov	Count: 8 Last: 18/Aug/16 4:04 PM	jira-software-users Support	JIRA Software

Figure 10. RE-PROVO Role Assignment

Points (Figure 11) are assigned for the following key activities: comments, challenge creation, requirement morphing. Points are also awarded for lower level activities such as editing, mentioning another user, keeping track of a requirement on a personal watchlist. Since the Jiraffe add-on already offered this functionality, it was preserved so that all potential user actions could be recognized and counted.

A user starts watching an issue	1	Top Analyst
A user stops watching an issue	1	Top Analyst
A user mentions another user on an issue	1	Top Analyst
An issue is closed	10	Engager
An issue is commented	1	Engager
An issue's comment is deleted	-1	Engager
An issue's comment is edited	1	Engager
An issue is created	3	Top Analyst

Figure 11. RE-PROVO Point Assignment

Four different badge types (Figure 12) are assigned at ten point intervals (the default scheme utilized by the Jiraffe add-on).





Badges			
Create the badges to reward your users.			
#	Name	Description	Points
	Rubber Ducky	Floating along just fine	10
	Top Monkey	Ya Know How to Play	40
	Apex Species	Swimming Without Looking Back	20
	Master of the Sea	Navigating the Waters Like a Pro	30

Figure 12. RE-PROVO Badge Assignment

When heritage keepers log in, they see a dashboard with the following activity streams: Heritage Challenges Issued (Figure 13), and Morphings

based on Innovation Challenges (Figure 14). Similarly, when innovators log in, they see a dashboard with Innovation Challenges Issued (Figure 15), and Morphings based on Heritage Challenges (Figure 16).

View: Heritage Challenges		
T	Key	Summary
	LEIS-21	Heritage Challenge to Requirement: Crime reporting online: suspect info
	LEIS-20	Heritage Challenge to Requirement: Fingerprints: Attaching to incident print-out
	LEIS-13	Heritage Challenge to Requirement: Crime stats: Online access
1-3 of 3		

Figure 13. RE-PROVO Heritage Challenge Activity Stream

View: Morphs Based on Innovation Challenges		
T	Key	Summary
	LEIS-18	Morph based on: Innovation Challenge 10441
1-1 of 1		

Figure 14. RE-PROVO Morphs based on Innovation Challenges Activity Stream







View: Innovation Challenge		
T	Key	Summary
	LEIS-16	Innovation Challenge to Requirement: Enable Patrol Blog
	LEIS-15	Innovation Challenge to Requirement: Incident - Skeleton Entry in RMS
	LEIS-14	Innovation Challenge to Requirement: Frequent Offender List: Appending notes to online map
	LEIS-12	Innovation Challenge to Requirement: Crime stats: Online access
	LEIS-11	Innovation Challenge to Requirement: Evidence: single point of entry
	LEIS-10	Innovation Challenge to Requirement: Missing Persons Postings
1-6 of 6		

Figure 15. RE-PROVO Morphs based on Innovation Challenges Activity Stream

View: Morph off Heritage Challenge		
T	Key	Summary
	LEIS-19	Morph based on: Heritage Challenge 10439
	LEIS-17	Morph based on: Heritage Challenge 10439
1-2 of 2		

Figure 16. RE-PROVO Morphs based on Innovation Challenges Activity Stream

5.2. RE-PROVO Game Evaluation Sessions

Two evaluations were conducted to assess whether RE-PROVO could help achieve research objective d) as set out in Chapter 1: ‘to develop and evaluate the utility of a game to enable a structured discussion of requirements along the themes of risk aversion (legacy preservation) and innovation, to foster creativity in business (functional) requirements analysis and development during legacy system replacement projects.’

The first group of practitioners was from a public library institution. They were deemed an appropriate evaluation group as library staff are employees of public sector organizations. With libraries frequently operating large-scale legacy systems which have reached their end-of-life, replacement projects are often underway. In this first evaluation of RE-PROVO, requirements for a new Integrated Library System replacing legacy cataloguing and patron management software were the subject of discussion. The second evaluation was conducted with employees from a different government agency and a substantially different domain – public safety and law enforcement. The requirements included in the game were

from applications related to crime analytics, evidence management, incident records, and frequent offender lists. This second evaluation incorporated lessons learned from the first evaluation session.

As the game evaluations were being planned and prepared, the question of whether requirements from real projects carried out at the participating organizations, or requirements associated with hypothetical IT legacy systems should be used in the game, needed to be resolved. Both approaches have drawbacks and benefits. In the former scenario, an assumption could be made that participants might be more at ease when issuing challenges and critiquing the requirements, because this would not imply questioning actual system setup or management decisions at their organization. However, a potential drawback would be that the players may not feel they have a sufficient understanding of a hypothetical system. In the latter scenario, even if the participating organization does not have constraints with sharing project information, the game administrator may not be able to properly re-formulate, group or edit the requirements so they can be used in the game, due to lack of familiarity with the domain, the system or the organizational context. In the end, both approaches were tested. In particular, for the first evaluation with public library practitioners, the chosen requirements were for a hypothetical Integrated

Library System, while for the second evaluation with the law enforcement agency, the requirements were from actual agency projects, but the participants were not equally familiar or involved in all of these projects.

For purposes of the evaluations the JIRA software was licensed for 10 users and installed on a self-hosted server. A custom domain – www.egov-requirements.org, was used to access the RE-PROVO game. The players logged in to the system under fictitious usernames pre-defined by the game administrator to ensure their anonymity, and were provided an initial password which they could later change.

5.2.1. Broward County Library

The first evaluation was carried out with employees from the Broward County Library (BCL), a public institution funded by Broward County in Florida, the United States. The recruited participants included nine individuals at different seniority levels in the organization ranging from interns to heads of departments. Only one participant had an IT background. In the following, the terms “players” and “participants” are often used interchangeably.

The requirements for the game were not based on an existing project at BCL because at the time of the evaluation there was no active system replacement effort that could be co-opted as the basis for a RE-PROVO

session. However, the organization was set to replace its Information Library System (ILS) in the future, and with that in mind appropriate requirements were obtained from a collection of surveys submitted by libraries across the world regarding their consolidated information systems, and the transition processes from one type of software to newer ILS systems (Breeding 2016). Special attention was given to the free text comments in the surveys, where specific issues and experiences related to legacy replacement were shared. An additional source were academic case studies on library software implementation (Gutierrez, 2014). These “real-world” scenarios were reformulated as requirements for the purpose of the game because they described authentic challenges specific to the domain of library management and library information systems, and would hence be familiar to the participants in the game evaluation. Requirements were listed along with a short problem and organizational/business context description, aimed at supporting the understanding of the requirements and minimizing ambiguous interpretations by the players. Requirements and context statements are given in Appendix F.

Communication with the majority of the participants was primarily by electronic means, although several were met in person before the start of the evaluation in order to coordinate the session. No group meetings or

orientation sessions were organized due to the time constraints the practitioners had as working professionals. Instead, they were emailed information about the research, a link to the risk analysis questionnaire used initially for the focus group session, and instructions on how to play the game. Seven of the nine participants completed the risk attitude profiler questionnaire, and the majority of responses indicated a strong propensity of the group as a whole towards taking risk and innovation. Since the purpose of the risk profiling questionnaire was to assign players to the roles that most closely aligned with their personalities, virtually no heritage keeper assignments could be made based on their data. As a result, the roles were assigned randomly, and individual emails with role assignment, anonymised user name, and initial password were sent to the players. The game session was set to take place over a two weeks' period, but due to low activity level, the gameplay period was subsequently extended by a week. During this timeframe the participants would log in to the game whenever they decided to. The game administrator was available by email or phone if assistance was needed.

5.2.1.1. BCL Session Outcome

Out of the nine players, two never logged in or participated in any way in the email exchanges, or in the game itself. One player, after reviewing all requirements in the game, communicated that these were too similar to a draft request for proposals (RFP) for a new integrated library information

system for BCL. This player was a member of an evaluative committee for the RFP, and after consulting with a supervisor, recused themselves from participation in the study due to a perceived conflict of interest. The other participants logged in a total of 32 times, with most participants logging in three to four times, and two being significantly more active. Five challenges were issued, but no morphings were generated, and no requirements or challenges were ranked using the star ranking feature. A call to vote on requirement versions was not issued, because there were no morphings available to be voted on.

The low level of participation in the game was initially attributed to low interest in the research project, or to the participants' lack of spare time to conduct the game evaluation. However, post-game face-to-face interviews were performed with five of the practitioners and a different assessment emerged.

5.2.1.2. Participant Feedback

The participants in the evaluation were each asked the following six questions:

- 1) *What was your overall impression when you logged in?* This question aimed at generating commentary on the user interface of the game.
- 2) *What do you think this game/tool is ultimately helpful in doing?* The goal of this question was to gauge RE-PROVO's general utility (or lack thereof) in an organizational context as framed by the interviewees themselves.
- 3) *Do you think the challenge discussion structure encourages people to talk about innovation versus risk aversion specifically?* In this instance the interviewees were asked directly if the game was successful in enabling a discussion of legacy versus innovative features in the proposed system. This question is directly aligned to research objective d) in Chapter 1.
- 4) *Why do you think no one suggested requirement morphings?* This question was formulated specifically to reflect on what occurred during the game session with BCL; since no morphings were generated it was important to find out why directly from the participants.
- 5) *Did you ever click on the pirate game section and why?* In this question the aim was to determine how important the game rewards (badges and points) were for participants, and if they were interested in the competitive elements of RE-PROVO.
- 6) *What would make people be more active and engaged in the game?* Since the game participants had become familiar with the RE-PROVO interface, rules and mechanics, the final question was intended to seek out specific ideas and suggestions on how those could be made more appealing and engaging.

The responses are summarized as follows.

The interface was overloaded and confusing to most participants. They felt it was busy and they did not know where to start – as one participant noted

‘I could see where to read things, but not where to react to [them].’ Another stated: ‘Components everywhere [that] didn’t relate to each other.’ The unfamiliar layout left them confused and unable to take actions within the game: ‘It was busier than I thought it would be, [there were] a lot of places to look.’ This was the primary reason for their lack of activity in the game. Additionally, they felt the materials they were provided with as guidance were too lengthy and too extensive to peruse: one interviewee in particular commented ‘I tend to be a direction reader – but they [the directions] were long though.’ Some felt they should have been hand-held more, and an in-person session would have substantially improved their understanding of how the game is organized and should be navigated – in the words of a participant: ‘it would have been better if you met with us.’

The overall concept of a structured discussion with heritage preservation and innovation roles and their respective challenge actions was well-accepted. The players could envision how with better visual layout, such a message board tool would be very useful for their organization, since individuals typically do gravitate towards either an innovative or a risk-averse persona. According to one participant ‘it makes a lot of sense from a theoretical perspective, because people tend to be divided along those lines.’ Also, playing a role that is different from one’s natural inclinations

might be particularly useful – ‘I was able to take on the persona, but I could see how it would be a challenge for some people.’

A number of participants also felt they were not at ease with the concepts surrounding Integrated Library Systems. Even though the features listed were fairly generic, if some of the participants had not actively used such technology specifically, they were hesitant on issuing challenges and suggesting requirements modification for it. The players who were interns in BCL were particularly reluctant to make suggestions given their lack of experience with library operational processes, or in the words of a participant: ‘[I felt] nervous – because we did not know a lot about ILS – the description was good but I felt uncomfortable.’

Not many players visited the game tab. It was noted that in order for the points and rewards to have a tangible influence, they must be immediately visible. One player suggested: ‘People didn’t see it – it wasn’t obvious. I would change the opening screen to show the point total for me versus someone else.’

To the question asking why there were not any requirements morphings generated during the game, they overwhelmingly stated that it wasn’t clear how to do so, or in one case that the formulations of the requirements sounded too “authoritative” to be questioned or modified.

5.2.1.3. Lessons Learned

The main realization from this game session was the importance of face-to-face communication with participants to ensure their understanding of the purposes of the evaluation, and to also confirm they have a good grasp of how to play the game. Even though email was their preferred mode of communication initially, as it was seen as a time-saver, it turned out to be insufficient as a single mode of communication.

Furthermore, from the post-game interviews, it became evident that the morphing and challenge dialogue menu did not encourage players to type in their own critiques or new requirement formulations. As a result, a modification was made to the RE-PROVO interface to prompt users specifically to define challenges in their own words, rather than use problem categories from the pre-defined checklist. Similarly for morphings, the text of the initial requirement was not repeated in the morphing dialogue to avoid confusion.

By and large, the interviews with participants from BCL helped shape the communication and game instructions materials which were developed for

the consequent evaluation, where clarifications on the challenge and morphing concepts were included. An explicit confirmation also needed to be made that in-depth technical or business knowledge is not needed in order to pose challenges or suggest a reframing of a requirement, and that the player can even make assumptions about business processes they can base critiques or justifications on (since the BCL participants shared they felt they didn't know enough about integrated library systems in order to question or modify the initial requirements). In other words, participants need to be encouraged to be creative, and to be assured that there are no right or wrong answers – all constructive comments are safe to make in the ensuing discussion during the game.

5.2.2. South Florida Police Department

The second evaluation was carried out with non-sworn (civilian) employees from a Police Department (PD) in South Florida, the United States. The recruited participants included six individuals working in different units of PD: crime analysis, information technology services and the field technology team. In terms of positions in the organizational hierarchy, several participants were in managerial positions, a couple were senior level staff, and two were junior level analysts.

The requirements for the game were derived from ongoing projects at PD

which involved the replacement of either a legacy application or a legacy operational process with new technology. The majority of the participants had first-hand knowledge of these projects, but even those who were not directly involved in them had a basic understanding of the issues and software, and the underlying business processes which were referenced. As in the BCL evaluation, the requirements were listed along with a short problem description, which was intended to prevent ambiguous interpretations by the players. The requirements and context statements defined for purposes of the PD evaluation are not provided as an appendix due to their confidential nature.

Communication with all participants for the purpose of coordinating the game session was done in person. They were all sent information about the present research and instructions on how to play the game by email as well, and they were also provided with a hard copy “cheat-sheet” to guide them through common game actions and rules. In order for the RE-PROVO evaluation to be as similar as possible to the session with BCL, the risk profiling questionnaire was not used, and the roles were assigned using a random procedure. Instead of individual emails listing the player’s role and their anonymised user name and initial password, personalized hard-copy handouts were provided to the players. The game session was initially

set to take two weeks, but due to a slower upstart in the first week the gameplay period was extended by a third week. As in the previous evaluation, during this time the participants logged into the game whenever they choose to do so, and the game administrator was available by email, phone or in person if assistance was needed.

5.2.2.1. PD Session Outcomes

The participants in the PD evaluation were generally more engaged in the game compared to the BCL participants. All players logged in several times and participated in the game by performing different actions. They accessed the game a total of 43 times and nine challenges and three morphings were issued. The challenges and morphings however did not necessarily conform to the intended format – some of the critiques were generic, rather than specifically formulated to point out a requirement's adherence to the legacy model, or a risky departure from it. Only one challenge and one morphing were ranked. A call to vote was issued, even though there was only a small number of morphings created and available to be voted on. During the session one player remarked that they could tell the identities of the other players by hovering over a specific section of their profiles, and viewing the email addresses displayed as an alt-tag. After this was revealed, the email addresses were changed by the game administrator to generic addresses which did not disclose the users'

identities.

5.2.2.2. *Participant Feedback*

Five of the six participants discussed their RE-PROVO experience with the researcher. Depending on their availability, they were interviewed either in person, or submitted their feedback about the game using an online questionnaire, which included most questions used with BCL participants, but was adjusted for the specifics of the PD session.

The Police Department participants were asked the following:

- 1) *Was the objective of the game clear to you? Did you have to consult the user guide or the cheat sheet?* The question was added as a result of player feedback from the initial session which suggested that it was unclear what the players need to do and how they should get started.
- 2) *What was your overall impression of the interface (GUI) of the game?* This question is the same as in the BCL post-game questionnaire, but the term “GUI” was included because most players in PD had an IT background.
- 3) *How did you feel about the game being anonymous? Did it matter to you who had the same role as you and who had a different role?* These questions were asked because during the game players shared that they were interested in the others’ identities.
- 4) *The game aims to structure the discussion around innovative requirements versus those that preserve existing processes. Do you*

think the innovation and heritage challenges encourage people to talk about systems in that way? The question is similar to question 3) in the BCL questionnaire and is directly aligned to research objective d) in Chapter 3.

- 5) *Why do you think the players didn't create a lot of morphs (i.e. didn't change the original formulations of the requirements)?* While several morphings were created in this game session, unlike in the BCL game, their low number necessitated this question.
- 6) *Did you ever click on the game tab "Jiraffe" to see your points and badges, or your pirate character? Did you visit it more than once? Were you interested in the other players' points?* These questions are similar to question 5) in the BCL questionnaire; their objective was to assess if the gamification element attracted the players' attention.
- 7) *What features would make players be more active in the game – for example post more comments, challenges or morphs?* Question 6 from the BCL interviews was split into two questions: this question which focuses on specific features to increase player activity and engagement, and question 9) described below.
- 8) *Was the game fun or interesting for you?* Since there was more activity logged in the PD game session, it seemed appropriate to ask if the experience was entertaining.
- 9) *How can the game be made more fun and engaging, in your opinion?* As the last question (question 6) in the BCL questionnaire, the goal in this final part of the interview is to collect feedback for a potential RE-PROVO re-design, but the question was re-worded to allow for more abstract ideas specifically in regards to the fun, or ludic dimension of the game.

All participants in the evaluation stated that playing the game was a positive experience, and they thought RE-PROVO was a useful tool to

gather feedback and generate discussion – a “project marketplace” of sorts, as one person suggested. Another remarked: ‘This tool could assist in starting a discussion that would allow different parties to point out issues/concerns related to their specific divisions or process flow that the other part may not have been aware of/realized.’

The online/anonymous aspect of the game was definitely ranked highly, both in terms of convenience and also for its potential to generate honest arguments: ‘Anonymous was a good touch to the game. I find doing it that way keeps you guessing how things would play out’ or as another participant commented: ‘anonymity tends to create a less filtered environment, which would be more beneficial in instances where the objective is to create an honest dialogue of current processes/programs involving various employment levels and/or divisions.’ Participants also appreciated the element of competition in the tool: ‘[it] brings out the competitive side in you.’

In terms of RE-PROVO deficiencies, the user interface of the system was deemed confusing by most as it was for the BCL evaluation, and participants expressed difficulty navigating it. A player suggested the need

for a 'more intuitive user interface, [...] remove the hmmm how do I navigate around here. You should want to expend brainpower in the requirements and the game, not on how to access information or use the system.' For instance, the unified listing of all requirements was deemed hard to locate, and an overview of all actions conducted by other players was not readily visible after log in. However, another player felt that '[the GUI] was pretty straightforward and navigation was user-friendly.'

Several participants noted that it would be more beneficial if more requirements were available, because they did not feel at ease commenting and taking action on the requirements from some projects they were not deeply familiar with. The following related comments were made: 'some of the topics may have [required] more than a tech understanding of the process, and perhaps the reasoning behind the current process was unknown.[...] it may have been more [difficult to] morph the item,' and also: '[players would have been more active] with different scenarios. These were more geared towards law enforcement that other users may not be as familiar with.' These remarks indicated that even though the participants in the game evaluation were told their challenges and morphings can be somewhat hypothetical, and do not have to be entirely realistic as far as technology or business processes are concerned, they still made efforts to be factual and treat the game as a real requirements discussion.

The gamification elements such as points and badges were important to most but not all players, but even then they were of secondary interest. As the point feedback was not immediate and the pirate character theme (see Figure 9) was not directly embedded in the individual requirements screens, the players did not visit the Jiraffe tab very often and did not fully appreciate the game elements. No participant kept up their activity just to accumulate points or earn a badge (although one player asked about the conditions to “level up”), which alludes to the importance of intrinsic motivation – in this case to generate a meaningful critique, or propose a good solution to a problem.

In terms of the heritage preservation and innovation themes, all participants expressed the view that having the challenge actions available for their respective roles does help structure and focus the requirements discussion and requirements analysis effort around the topic of whether legacy features should be replicated. Some players felt they naturally gravitate towards an opposite role than the one they were assigned, but they felt it presented a good opportunity to explore a different perspective. One player remarked that generally IT staff gravitate towards an innovator persona: ‘IT [people] are mostly innovators because there is always new

technology we want to try. It is the business side that often wants to preserve things the way they are.’ This illustrates the need to determine which role assignment method is indeed most suitable for generating more dynamic gameplay in RE-PROVO – a random one which enables players to act differently from what their natural predisposition dictates, or one that matches their inclinations and allows them to make more authentic comments and critiques.

5.3. Discussion

The first evaluation session with Broward County Libraries demonstrated the importance of direct communication with participants and the need to ensure they had a proper understanding of the game prototype’s purpose and setup, prior to the commencement of gameplay. Even if electronic communication was chosen as the preferred method of interaction due to the participants’ own time constraints, in the end they expressed consensus that self-study of the game’s documentation was not sufficient for them to develop sufficient grasp and command of RE-PROVO.

Furthermore, due to the asynchronous nature of the game, rhythm and momentum is not easily achieved even with active participation from the players. Therefore, the novelty of the game concept, its interface and technical features, and the difficulties that arise from the interrupted engagement with the tool, could be offset with a different type of involvement from the researcher/game coordinator. As a result, a modified

approach to recruiting and engaging game evaluation participants was employed in the PD session. More direct contact was made, auxiliary materials were developed in different formats, and communication was carried out through multiple channels. This led to a higher level of participation in the game and to a more thorough try-out of RE-PROVO features.

Taking part in the game evaluation was largely an interesting and rewarding experience for all the participants as new concepts, a novel tool and a different approach to discussing requirements were presented for their assessment. While the public sector practitioners who participated in both evaluations were introduced to RE-PROVO as a game, most of them treated it in effect, as a general discussion or message board tool, and appreciated being able to discuss and argue on work-related topics online. Regardless of the addition of elements such as points and badges, the subject matter and content of the requirements being discussed took precedence over the entertainment, or ludic aspects of the experience. This, however, was not detrimental to the effectiveness of the concept of a structured discussion around the themes of heritage preservation and innovation in legacy system replacement projects. The roles in RE-PROVO were clear and relatable to the players, because they matched existing

organizational stereotypes. The challenge concept was generally understood as well, however the critiques posed to the requirements were not always constructed within the particular heritage or innovation delineation. This was mostly due to the requirements themselves – participants did not feel confident they had sufficient background knowledge to discuss them (even after they were encouraged to make arguments that are somewhat hypothetical for purposes of the gameplay), so they were non-committal: they would critique but in more general terms, and would not suggest a requirement reformulation with confidence.

Another potential explanation for the paucity of challenge and morphing activity in both sessions is that structured argumentation is typically more difficult and restrictive, even if it is more suitable in the context of the legacy problem. To fulfill the ontological objectives of the triadic game design framework, RE-PROVO should be evaluated within a real legacy replacement project where the participants are actual stakeholders, so they can issue authentic challenges and feel confident to develop morphings. A firm conclusion from the evaluations is therefore that requirement formulation matters significantly. It is important to specify the requirements in a way that makes them both open for discussion and gives sufficient context for their analysis. In the case of the derivative requirements given for an Integrated Library System, the context shared

may not have been extensive enough to give ideas for proper challenges and morphings. In the session with Police Department the context was sufficient for a higher level discussion, but not one that drilled down concretely into the legacy replication aspect of the projects.

5.3.1. Assessing RE-PROVO Using the SGDA Evaluation Framework

In the field of serious games, some frameworks for evaluation have been developed recently which could be used to assess if a game is properly designed and could produce knowledge, behaviors and attitudes that are transferrable outside its ludic context into the workplace/real world. The SGDA (Serious Games Design Assessment) framework (Mitgutsch & Alvarado, 2012), for instance can be used to supplement the practitioner evaluations of RE-PROVO. SGDA includes the evaluation of the following game elements – content/information, framing, mechanics (rewards, rules etc.), fiction (narrative/roles) and aesthetic/graphics. It regards serious games as purpose-based games where entertainment is not the end goal, hence the educational or business purpose of the game needs to be reflected within all the listed elements.

In regards to the content criterion, the data included in RE-PROVO were requirements from legacy replacement projects. The relevance to the

purpose of the game is therefore high and the content well-suited. It must be noted that the practitioner evaluations of RE-PROVO highlighted the importance of how the requirements are written and presented. Some pertinent guidelines could be: that the requirements be defined as neutrally as possible in relation to the themes of legacy and innovation; that some context as to the problem space be provided so practitioners do not feel disadvantaged due to lack of background knowledge; that this background description do not incorporate potential alternatives to the requirements (that is what the players should generate); that the terminology used in the requirements be not too technical or utilize business jargon excessively, so that all players can understand them, etc.

Framing, the next criterion, refers to ensuring the match between the participants' play literacy, i.e., their experience level with the game technology and with gaming concepts. Framing in the case of RE-PROVO was essentially left to the supplemental "How-To" materials and the instructional documentation, with no framing mechanisms embedded in the game itself in the form of prompts, help pop-ups, or automatic step-by-step walkthrough. For purposes of evaluation of the game concepts related to the Potts et al.'s Inquiry Cycle and the game roles, this type of framing was not a substantial problem, but in a production-ready game it would be considered a deficiency.

In terms of game mechanics (issuing challenges, morphing, voting and assigning points to these actions) the game is straightforward, however not particularly exciting. In future iterations these game actions should ideally be supplemented with better visuals or more expressive metaphors. As far as fiction and narrative are concerned, the only concepts representative of this element were the innovator and heritage keeper roles, and these were not incorporated as part of a story. The pirate theme of the points section was not narratively tied to the roles either. This lack of attention to the fictional story component in RE-PROVO was due to: 1) the attempt to make the game domain agnostic (a single narrative relatable to all contexts would have been difficult to develop); and 2) the technology constraints (it was not feasible to embed the narrative functionally or graphically in JIRA). There is a possibility that the presence of a narrative would have made RE-PROVO more engaging, but this would have to be confirmed through more gameplay sessions.

Aesthetics and graphics, and the GUI layout, were the biggest weakness of the game as they reduced the usability of the software. As there was no overarching narrative theme, there were no corresponding graphics to be incorporated throughout the screens, but more importantly, since JIRA is

an issue tracking and a project management system, it offers minimal options for aesthetic improvement.

The final SGDA criterion is how these elements relate to the game's overall purpose, i.e., cohesiveness and coherence. If we regard RE-PROVO as a serious game, the conclusion is undoubtedly that it lacks cohesion because of the missing narrative components which could strengthen the linkage between all other elements. However, this does not mean that RE-PROVO is not an effective tool for practitioners. If we are to apply project management criteria, RE-PROVO seems to accomplish important goals from a requirements engineering perspective.

5.3.2. Assessing the Value of RE-PROVO as a Requirements Tool

In their analysis of information system requirements processes in the public sector, Klier et al. (2016) establish four success factors for requirements engineering processes applied to complex government projects: communication, decision-making transparency, multi-stakeholder collaboration and the interleaving of the requirements process with the organization's IT governance model. RE-PROVO enables structured communication between multiple stakeholders through its challenge and morphing, voting and commenting features. The decision-making transparency requirement is fulfilled by the visibility of players' votes and

the visualization of the discussion threads. Although the players are anonymous, the discussion around each requirement, which includes objections raised and justifications provided, can be easily perused. The final success factor – interleaving with the IT governance model of the agency - could be satisfied if the game is co-designed by practitioners from the organization employing it. That way IT governance process elements unique to the organization could be incorporated in the game. In fact, this final factor also relates to the question of the extent RE-PROVO is a simulation game or whether any suggestions made in the course of the game will be actually considered for implementation (as an evaluation participant from PD specifically inquired). The answer to this question will depend on the organization employing the game and its willingness to experiment with game-based tools by incorporating them into its decision-making process.

While the Potts et al.'s Inquiry Cycle certainly lends itself to being augmented with game elements (i.e., is “gamifi-able”), for a better assessment of whether the game competitive model itself boosts the discussion of requirements where uncritical legacy replication may be evident, RE-PROVO may need to be fine-tuned as a more immersive and narrative-driven game through further interface and game mechanics

adjustments.

5.4. Threats to Validity

Undeniably, the evaluation of any software prototype has limited generalisability. Although the goal was primarily to evaluate the RE-PROVO game *concept*, there was no way of exploring the flow of the requirement morphing cycle and the anonymous challenge-based interaction between participants effectively other than through a high-fidelity online prototype. Such prototyping however has been known to have disadvantages for the identification and analysis of conceptual approaches (Rudd et al., 1996). This is because content/concept cannot be easily divorced from appearance/design. The very technical elements that made such an evaluation possible also got in the way by diverting attention from the conceptual structure of the game: the graphical user interface elements often confused the participants and became of primary interest to the players.

Although concept evaluation through a prototype is definitely challenging, the assessment of the concept can be separated from technical design issues with appropriate post-evaluation feedback gathering and analysis. For instance, the players were asked to comment on conceptual elements such as roles or challenges separately from the graphical representation of the game. Whenever applicable in the face-to-face interviews, after

commenting on their game experience, players were asked follow-up questions to distinguish between the model for the game and its implementation, and some gave suggestions on how the user interface can be improved, which demonstrated that they were able to distinguish between the RE-PROVO concept and its implementation.

A further weakness of the research was the inability to evaluate the game using requirements from a project all practitioners were directly involved with. This resulted in the inability to determine conclusively the utility of the game using criteria other than the participants' feedback, which might have been skewed by factors such as novelty effect and Hawthorne effect which are highlighted in literature as common issues during similar evaluations (Gravetter & Forzano, 2015; Abt, 1987). Therefore, any conclusions on the potential usage of RE-PROVO or similar games and tools during the requirements phase of legacy replacement projects should be treated as provisional and subject to further confirmation.

5.5. Chapter 5 Summary

A modification of the PROVO game was carried out after the playtesting and focus group sessions discussed in Chapter 4. The resulting re-design

was branded as RE-PROVO and implemented as a prototype on the JIRA issue tracking software platform. Two separate groups of government agency practitioners were engaged to evaluate the prototype and assess if the game enables discussion of requirements for the replacement of legacy systems following the themes of innovation and risk aversion (heritage preservation). The first evaluation with employees from the Broward County Library resulted in a low level of activity due to participants' difficulties with the tool interface. The second evaluation with employees from a Police Department in South Florida was carried out after more preparatory activities with the participants and resulted in more active gameplay. The analysis of the outcomes of both sessions established that the general model of innovation and heritage keeper roles, coupled with a challenge and response process, constitutes a successful mechanism for focusing practitioner analysis on the legacy problem. However, improvements to the interface and features of the tool and to the actual content of the requirements are necessary to enhance the participants' experience and the overall effectiveness of the game.

Chapter 6: Conclusions and Directions for Future Research

Since the beginning of this doctoral research into the legacy problem, its manifestations and the potential means of addressing it (2010), there have been many opportunities to re-evaluate its formulation, gravity and significance. To begin with, in the very domain being analyzed – that of government information technology, the term “e-government” has been sidelined in favor of “digital government” and other niche concepts like open government, virtual government or transformational government have developed. The concept of bringing government systems online and automating manual business processes is no longer new or revolutionary, as it seemed in the first decade of the new millennium. However, it has not yet radically “graduated” to a more evolved form where issues such as compatibility and integration with legacy systems, or mismatches with older data formats are no longer a problem. Legacy systems continue to be an issue for government agencies. Remarkably, they have become an even greater financial and operational burden, as evidenced by a recent review of federal IT policy initiatives, where special funding mechanisms have been established specifically to deal with legacy system replacement (Charette, 2016). The definition of legacy systems has also expanded from a purely technical definition to one that incorporates organizational and social dimensions, which essentially confirms its salience. While at the

beginning of this doctoral research legacy technology was mostly synonymous with mainframe applications, six years later the definition has expanded to include any outdated technology platform, such as thick desktop applications or older web applications (for example .asp or Cold Fusion apps), etc. The legacy problem hence might be said to be perpetual and will not go away with the replacement of specific technology types.

Regardless of the continued attention, to date no major studies or surveys have been conducted that delve into the approaches government agencies specifically apply to replace outdated technology. Also, no cataloguing of requirements practices or methods utilized in such projects has been carried out. In fact, the requirements engineering discipline has not seemingly received much attention in the public sector's IT project management community, judging by the low number of academic publications dedicated to RE in government. "Requirements engineer" is not a position title that can likely be found in a public sector organization either.

On the other hand, a surge in the application of serious games in government organizations has been noted in recent years (Boinodiris and Fingar, 2014). Whereas the use of games to solve business problems in public organizations may have been considered frivolous when this dissertation was initiated, games are now seen as legitimate tools in the

areas of education and workforce training. While they are not necessarily mainstream applications as of yet, the successes reported with innovative serious games have made practitioners more eager to evaluate them, and this in turn has positively affected practitioners' readiness to conduct the RE-PROVO evaluations.

After reviewing the latest developments in technology, digital government practice, the requirements engineering domain and the field of serious games design, since this research programme was undertaken, it seems that the legacy problem was not a transient concern but rather continues to be significant, and the subject of this study – requirements engineering in the public sector, as well as the evaluation of games with a focus on requirements analysis creativity remain consequential, and highly relevant.

6.1. Conclusions

The main research aim of this dissertation was to examine current legacy system replacement practices in government agencies and to explore the viability of a game-based approach for analysis of business risks and opportunities in the requirements engineering process for these projects in

the public sector. The following principal conclusions have been drawn from the literature review and primary research undertaken.

Legacy systems are an ongoing problem for government agencies. Their functionality is often replicated in the applications that are meant to replace them, as a way of mitigating the risks associated with business process change. The business processes being preserved in this way originate in many cases from the technical constraints of the same legacy systems that are being superseded. This predicament is defined as the “legacy problem” and its circular nature, compounded by government agencies’ bureaucratized decision-making processes, renders it a type of wicked problem, per Rittel and Weber’s (1973) and Conklin’s (2006) definitions. From a requirements perspective, practitioners do not treat legacy replacement projects differently than any other IT project - no legacy-centric approaches are utilized. The requirements discussions during such projects are typically driven by two opposing practitioner attitudes: one promoting conservatism and risk aversion, and the other - innovation and transformation. These research findings fulfill the first dissertation objective – we have produced a detailed characterization of the current state of requirements engineering practices in digital government projects which involve legacy system replacement, as well as the third objective- assessing the attitudes expressed by digital government practitioners during the planning stages of legacy replacement.

As a result of the dominating influence of risk aversion, the most frequently adopted tactic during legacy replacement is the preservation of existing business processes and the replication of legacy features. The most common approach to move away from legacy technology is to replace it with COTS products. Coupled with the inclination to preserve existing processes this results in increased spending on COTS customizations, and on missed opportunities for organizational innovation and improvement of public services. These observations derived from the survey and interview data collected, establish the extent and manner in which legacy systems and business processes are reproduced in new solutions and applications, which was the second research objective of the dissertation.

As the existing bureaucratic structures and processes in government agencies favor risk aversion, methods and tools to promote innovative perspectives and to stimulate discussion during legacy replacement efforts must be applied. Gameful online requirements discussions are a promising approach towards ensuring practitioner creativity when defining the requirements for replacement systems. Some recent developments such as the “argument web” (Bex et al., 2013) and Collaborative Computer-Supported Argument Visualization (Iandoli et al., 2014) have validated the need to structure online discussion tools better and to categorize and

interconnect opinions and dialogue through semantic linking technology in order to improve argumentation. Gamification can also be successful to that effect as it provides the platform to reinforce and reward structured discussions and actions, specifically in terms of competition and dissent, as well as by allowing for anonymous participation. Additionally, our findings dictate that a requirements game must be easy to play both from a conceptual and technical perspective, must feature pertinent requirements, and offer immediate interface-driven feedback to the players.

The game alone cannot guarantee positive outcomes however. Our focus group, described in Section 4.5.2., conclusively demonstrated the significance of agency/organizational context and how the game should be framed for practitioners: it confirmed that no tool or game could be successful unless it is introduced in a way that takes organizational culture and values into account, and sets the stage for the discussion in an optimal manner, ensuring participant “freedom of speech”, the provision of meaningful incentives, and the consideration or potential organizational adoption of players’ suggestions.

The topic of incentivisation, either through the game itself or within a specific government organization, was also broached during our research. The feedback during both the focus group and the RE-PROVO evaluations indicated that proper incentivisation is dependent on a combination of the

participants' individual motivation and what is considered valuable in the given agency – whether time off, formal recognition from management, a monetary reward, etc. , so no one-reward-type-fits-all model for the game could be arrived at. As a result, the basic Points -Badges-Leaderboards (PBL) model (Deterding, 2012) was utilized for purposes of the technical prototype of the game as a standard gamification mechanism that end-users are possibly accustomed to from other software applications.

Even though the ideal model of game development distinguishes between a technology-agnostic conceptual design phase and an implementation phase, with the assumption that technology can accommodate fully the predefined design parameters, the reality is that technical constraints often determine the design choices (Chaffin & Barnes, 2010). This was (to a degree) the experience with RE-PROVO as well, as it involved customizing a platform (JIRA) which was by default neither game-based nor purely discussion-based. This ultimately affected both evaluation sessions carried out with public sector practitioners. The graphical user interface was a significant factor in how the users experienced RE-PROVO, and in the case of Broward County Library it impeded gameplay substantially. A finding from the sessions was that the PBL (Points –Badges - Leaderboards) elements were rarely sought out intentionally, possibly because they were

not integrated within the requirements screens. In Chapter 5 analysis this is discussed as a weakness of the game GUI design; however this separation can be used as an instrument to test if there is interest in the competitive game components per se. From the RE-PROVO practitioner evaluation, one can conclude that the competitive gaming elements in and of themselves appear of little value; however if properly integrated they could potentially boost interest and engagement. In fact, proper design and integration of game elements into business applications is one of the top issues in gamification currently: Gartner analysts predict that gamification will enter a trough of disillusionment precisely because poorly designed gamification applications have failed to deliver value (Burke, 2012).

The other key determinant of the quality of the user experience in RE-PROVO were the requirements themselves. The evaluations led to the conclusion that practitioners did not feel at ease with requirements from projects they did not have direct and active involvement in, even though these requirements may have been derived from actual systems and from the same domain the practitioners operated within. This leaves a question unanswered by the present research - are there circumstances which will favor the use of hypothetical requirements in the game? Related to this is a question of whether in RE-PROVO actual requirements would encourage the generation of morphings, while hypothetical requirements - the generation of challenges.

The evaluations of PROVO as a design concept, and of the RE-PROVO technical prototype effectively assessed the utility game elements (or gamification) can have for the more structured discussion of requirements along the themes of legacy preservation and innovation, as stated in the fourth objective of the dissertation. Creativity and engagement in requirements discussions are indeed likely outcomes of the proper introduction of games in the context of public sector IT projects for systems replacement.

6.2. Contribution to Knowledge and Practice

The use of gamification in government legacy replacement projects is a novel approach that aims at promoting innovation and encouraging practitioner creativity during requirements analysis: the context and the tool itself are an uncommon combination in both practice and academic research.

This doctoral research was motivated by a problem in digital government practice which had not been hitherto defined holistically and had only been sparsely considered in academic literature. The challenges posed by the

process of migrating away from legacy systems have been typically classified in technical and financial terms primarily, with less attention afforded to its potential effects on an organization's operations. The literature reviewed in Chapter 2 either did not treat legacy replication as problematic, or did not review it distinctively in the context of public sector bureaucracy, or did not identify its locus in the requirements phase of legacy replacement projects. What the online survey and qualitative studies added to the discourse was the focus on replication of legacy features during the requirements phase specifically and its underlying causes in government organizations.

The identification and formulation of the legacy problem has implications for both the disciplines of digital government and that of requirements engineering. Digital government studies are overwhelmingly concerned with government institutions' ability for transformation and innovation, yet without the recognition of the strong "gravitational pull" of legacy processes as embedded in and represented by legacy IT systems such research would be limited. Acknowledgment of the socio-technical nature of the legacy problem also promotes techniques and solutions that address the social dynamics around legacy systems replacement.

In the requirements engineering domain, problems pertaining to legacy system replacement have not thus far merited their own special

categorization. The findings from the survey and interviews, however, imply that the process of defining requirements for applications that replace legacy systems must be cognizant of practitioners' legacy bias and must require explicit justifications for preserving legacy functionality. The research presented here suggests that requirements negotiation activities can be structured around the heritage and innovation themes to more effectively channel the organizational conflict that typically surfaces during system replacement and to make it constructive.

Another contribution is the gamification of requirements activities. The experience with designing a game based on the Potts et al.'s Inquiry Cycle illustrates the potential of augmenting any requirements engineering framework with game elements. Such an approach bridges potential gaps between theory and practice by enabling the creation of tools that can be used more readily for the evaluation and application of requirements engineering concepts and methods. Furthermore, as noted by Mitgutsch and Alvarado (2012), serious games often have the capacity of generating discussion and positive attention just by virtue of their good cause and the unusual approach they embed. Practitioners therefore are more likely to see benefits by the mere act of introducing a creative approach in their

legacy replacement projects.

6.3. Future Research

In the course of the exploratory research of the legacy problem, a number of additional questions emerged which merit further academic research and practitioner inquiry. For instance, while the insight obtained from the survey data points to an ever-present tendency of legacy systems (as socio-technical entities) to reproduce themselves, there was a percentage of responses where practitioners did not feel this was occurring, pointing to factors which could lead to different outcomes, such as new systems features and changes to business processes. Additional understanding is needed into what these distinguishing factors are.

One of the research limitations discussed in Chapter 3 was that the low number of survey responses precluded analysing for potential associations between particular practices and the extent of legacy feature or process replication. Future studies will ideally focus on such linkages and potentially associate specific requirements practices with more innovative outcomes.

The design of a requirements game was an area of research ripe with possibilities for additional exploration. New features or adjustments to the

RE-PROVO design emerged as options while the evaluations were progressing, but their technical or organizational implementation was not feasible at the time. One such example is the use of actual requirements from projects that all players are, or have been involved in. As previously noted in Sections 5.2.1.2. and 5.2.2.2., the ontological content of the game – i.e., the requirements featured for discussion, was singled out as having significant influence on player activity and interest. Future evaluations of RE-PROVO (or similar requirements tools) will need to investigate specifically which scenario contributes to improved player engagement and creativity – one where the game is based on a real, ongoing project, or one where the requirements are hypothetical. Even more important than the gameplay itself, however, is whether the players' experience will have an impact on the outcomes of legacy replacement projects. A significant number of games, or gamified applications primarily affect areas that are ancillary to core operations, i.e., they enable educational activities and training, brainstorming, or employee networking (Rauch, 2013). In the case of RE-PROVO, the game evaluation was undertaken for research purposes, and even though it contained real scenarios and requirements from actual ongoing projects, it was primarily an exercise in deliberation, and its outcomes have no guarantees of impacting agency decision makers. RE-PROVO has been, in effect, a rehearsal for future discussions, just as many other games or gamified applications are primarily educational and

simulation tools. This echoes the notion of ‘procedural rhetoric’ introduced by Ian Bogost (2008), which posits that the main impact of games is to imply and teach a certain procedural model of the world. It would be a relevant line of inquiry to determine if requirements gamification can involve more than procedural rehearsals of requirements activities, but could be directly integrated into the management of legacy system replacement projects: for instance, versions of systems requirements with the most votes in the RE-PROVO game would automatically become a part of the new system’s specification document.

Another key element of the game – the role assignment – was singled out in practitioner feedback as an essential determinant of player experience. While some participants in the RE-PROVO evaluation noted that being assigned a role that did not match their actual attitudes towards organizational change was a helpful exercise (Section 5.2.1.2.), it is not clear how that impacted the game outcomes. Evaluation sessions that compare gameplay with reversed roles (natural innovators assigned as heritage keepers and naturally risk averse individuals assigned as innovators) and with matching roles (naturally risk averse individuals assigned as heritage keepers and risk-takers assigned to be innovators) would have to be conducted.

A valuable take-away from the RE-PROVO evaluations and the practitioner

interviews was also that game design may be as engaging and effective in addressing requirements problems during legacy replacement projects as gameplay itself. The possibility of involving practitioners in serious game design implied in Section 3.3.2.6. would be a worthwhile thread of future research. The increased availability of flexible serious game platforms in recent years would make such an approach plausible. As RE-PROVO is designed to provide support for practitioners to voice more freely opinions and suggestions about the features of new technologies in their organizations, it would logically follow to enable them to shape the game itself. The involvement of players in the definition of game rules and parameters would constitute an act of empowerment in the spirit of the Scandinavian tradition (Gregory, 2003), which engages end-users to co-create the software tools they would ultimately use. Furthermore as organizational culture substantially impacts legacy system replacement project outcomes, it is sensible to design tools that take into consideration the local agency context: 'co-operative [participatory design] approaches argue that workplace language and daily experience of users need to be placed centre stage in an effort to enable users. For enabling users implies not just using their experience, but creating and fostering an environment where they can feel empowered to express their ideas' (Greenbaum, 1993 cited in Gregory, 2003).

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Appendices

Appendix A – Survey Questions

The first set of questions will be about your organization's usage of legacy systems and their impact on its operations.

1. How would you characterize your organization's reliance on legacy systems?

- ☐ All business-critical systems are legacy systems
- ☐ Most business-critical systems are legacy systems
- ☐ Some business-critical systems are legacy systems
- ☐ A few business-critical systems are legacy systems
- ☐ No business-critical systems are legacy systems

(business-critical is defined as a system needed for the organization's daily operations)

If response is a, b, c, or d. then ask

2. Below is a list of issues that may result from the reliance on legacy systems. Please specify the impact they have on your organization)

- a. High maintenance costs
- b. Limited integration capabilities with other systems
- c. Limited customization flexibility
- d. Over-reliance on external/vendor support
- e. Slow change management processes
- f. Inability to accommodate new business needs
- g. Other (please specify)

(options for each response: Very High Impact-High Impact-Moderate Impact – Low Impact – No impact)

3. Relying on legacy systems may introduce certain benefits. Specify the impact of each benefit on your organization.

- a. Low maintenance costs
- b. High staff familiarity with the system
- c. System reliability
- d. Well-running change management processes
- e. Other (please specify)

(options for each response: Very High Impact-High Impact-Moderate Impact – Low Impact – No impact)

The next set of questions will cover how your organization goes about replacing its legacy systems.

4. What is the extent of the effort your organization is making to replace its legacy systems (feel free to approximate)?

- o No effort is currently taking place

- o A small number of staff members are dedicated to projects for the replacement of legacy systems, and/or a budget considered small for the organization is allocated
- o A moderate number of staff members are dedicated to projects for the replacement of legacy systems, and/or a budget considered mid-sized for the organization is allocated
- o A large number of staff members are dedicated to projects for the replacement of legacy systems, and/or a budget considered large for the organization is allocated

If response is a. then ask

You have indicated that your organization is currently not replacing any of its legacy systems. How does it deal (or intend to deal) with any new requirements that legacy systems cannot support?

.....

5. What is your organization's preferred approach to legacy systems replacement? (Specify how commonly each approach is applied.)

- a. Outsourced custom development
- b. In-house custom development
- c. Purchasing of Commercial Off-the-Shelf software
- d. Software as a Service
- e. Other (please specify)

(ranking scale : Always – Often – Sometimes – Rarely- Never)

6. How would you characterise the wider business impact of legacy replacement projects in your organization? (Select all that apply)

- ☐ Changes to operational procedures
- ☐ Organizational policy changes
- ☐ (Re-)Training of Staff
- ☐ Changes to staffing levels
- ☐ New organizational roles
- ☐ Other: (please specify)

7. Which issues that could potentially occur during legacy system replacement projects is your organization most concerned about? Rank based on how critical you deem these issues to be for your organization, where 1 is most critical and 9 is least critical.

- ☐ Project scope change, or scope "creep"
- ☐ Newly developed features introduce changes to business process
- ☐ Project cost overruns
- ☐ Project ran behind schedule
- ☐ Lack of skills to support new system
- ☐ Resistance to change in the organization
- ☐ Operational instability
- ☐ Lack of end-user satisfaction with new system
- ☐ Other. Please Specify:.....

8. How would you characterize the level of carry-over of features from legacy systems into the new applications that replace them?

- o No legacy features carry over
- o A few legacy features carry over
- o Some legacy features carry over
- o A lot of legacy features carry over
- o Almost all legacy features carry over

9. Why do old system features typically carry over in the new application(s) that replace legacy systems? Specify the frequency with which these factors play out in your organization.

- a. To minimize changes to business operations
- b. Because they are mandated by policies or legislation
- c. Because they have been stable for many years
- d. Because end-users are accustomed to them
- e. Because technical specifications for them are readily available
- f. Other. Please specify:.....

(options for each response: Always, Often, Sometimes, Rarely, Never)

The following section will include questions about the requirements practices utilized during legacy replacement projects in your organization.

10. Below is a list of potential sources of business requirements for the new applications/services replacing legacy systems. Please specify how useful they were for the projects you are familiar with, or involved in.
- a. Focus groups
 - b. Interviews of business users

- c. Interviews with IT staff
- d. Surveys of end-users
- e. Notes from project meetings
- f. Documentation of existing/previous systems
- g. Legacy system code
- h. Old system training manuals
- i. Studies conducted by consultants/other organizations
- j. Market research into best practices
- k. Social media research
- l. Feature listings in off-the-shelf systems or SAAS offerings
- m. Other. Please specify:.....

(ranking scale: Most useful – Very Useful- Somewhat useful- Barely Useful - Not useful – Not used)

11. Who typically carries out the gathering, documenting and/or analysis of requirements during legacy replacement projects in your organization? For each role mark one of: Always, Often, Sometimes, Rarely, Never

- ☐ Developers
- ☐ Systems analysts
- ☐ Interface designers
- ☐ Usability Specialists
- ☐ Project managers

- ☐ Technical writers
- ☐ Outreach specialists/PR/Marketing/Public Information specialists
- ☐ Administrative staff
- ☐ Consultants/Contractors/Vendors
- ☐ Business Analysts
- ☐ Requirements Analyst/Requirements Engineers
- ☐ Other. Please specify:.....

The final group of questions are about you (your position and the nature of your involvement in legacy systems replacement projects) and your organization's characteristics.

12. Are you personally involved in any ongoing or planned projects which involve the replacement or phasing out of legacy systems ?

- a. Yes
- b. No
- c. I have been involved in such projects in the past.

13. What is your role in this project/these projects?

- a. Project Manager
- b. Technical Decision-Maker
- c. Business Decision-Maker
- d. Developer
- e. Analyst
- f. End-User

- g. Executive Sponsor/Champion
- h. Other. Please specify:.....

14. What country are you located in?

15. What is your organization's jurisdiction level?

- a. Federal/National
- b. State/Regional
- c. Local/County/City

16. What is the size of your organization?

- a. Below 100 employees
- b. 100-1000
- c. Over 1000

17. What is the functional focus of your organization? Select all that apply.

- a. Environment
- b. Social Services
- c. Housing
- d. Taxes & Finance
- e. Building and Construction
- f. Transportation

- g. Public Safety
- h. Neighborhood
- i. Recreation and Culture
- j. Business Development
- k. Street/Roadway/Bridge etc. infrastructure
- l. Information Technology
- m. Other

18. What percentage of your agency's budget is spent on software systems and applications development?

(If you do not know, please leave the response fields blank)

- a. Percentage of overall agency budget
- b. I don't know the percentage, but I know the amount

19. What is your position in the organization?

- a. Systems Developer
- b. Systems Administrator
- c. IT Manager
- d. Business /Operations manager
- e. Elected official
- f. Business Analyst
- g. Administrative specialist
- h. Other IT specialist
- i. Public Outreach/Information/ Officer
- j. Consultant/contractor
- k. Executive level – CEO, CIO, Director, Agency head etc.

l. Other

20. Please provide your email address if you would like to receive the analysis of the study results.

Email address:.....

Appendix B – Interview Questionnaire

Legacy problem

How would you characterise projects which involve the phasing out of a legacy system?

Arguments /Discussions

How do discussions around the benefits vs. risks if introducing changes to business process with the implementation of legacy replacement systems typically play out?

Are legacy replacement projects typically contentious?

What do stakeholders usually disagree/argue about?

Are these discussions mostly between technical people, business people, or a mixture? Are any of those categories typically a consistent proponent of a typical attitude?

Roles

What to the proponents of legacy processes typically put forward as arguments in favor of their position?

How do the proponents of innovation generally support their suggestions?

Decision making

How does your organization decide what features the replacement system will have?

When there are two opposing views on the preservation or replacement of a particular feature or process, who decides which approach is adopted?

Requirements/Procurement Practices

What are the main practices for requirements elicitation that you use right now?

Procurement process

When purchasing an off the shelf system, how does the vendor of the system typically contribute to the discussion about preservation of old features/practices? Do they encourage or discourage innovation, or customisation of the system?

Which existing techniques/templates/approaches are particularly successful at

helping decide what legacy features to keep and which to phase out?

The Game

Would having requirements discussions during legacy replacement projects online be useful? What would make it more fun and less tedious?

If this was to be played out as a game, what would be a suitable reward/ win condition?

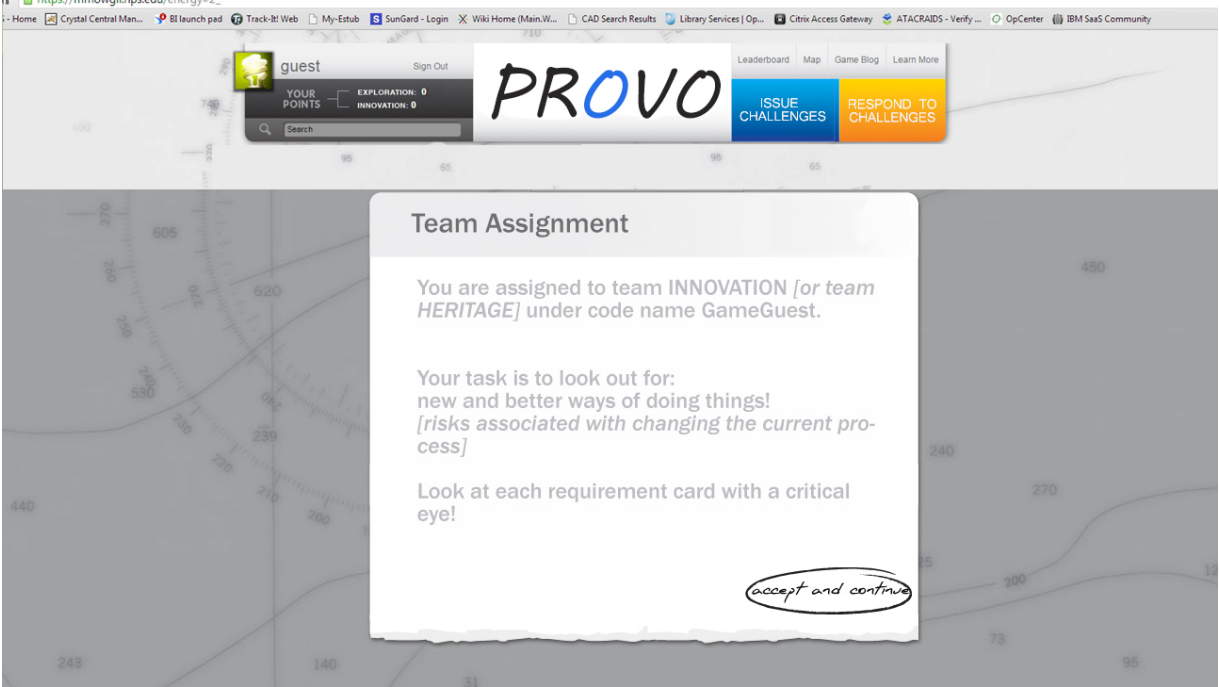
What would help practitioners sort out what processes are worth changing and which are worth preserving? What would promote an honest discussion?

Do you feel an online tool can assist with the requirements for replacement systems?

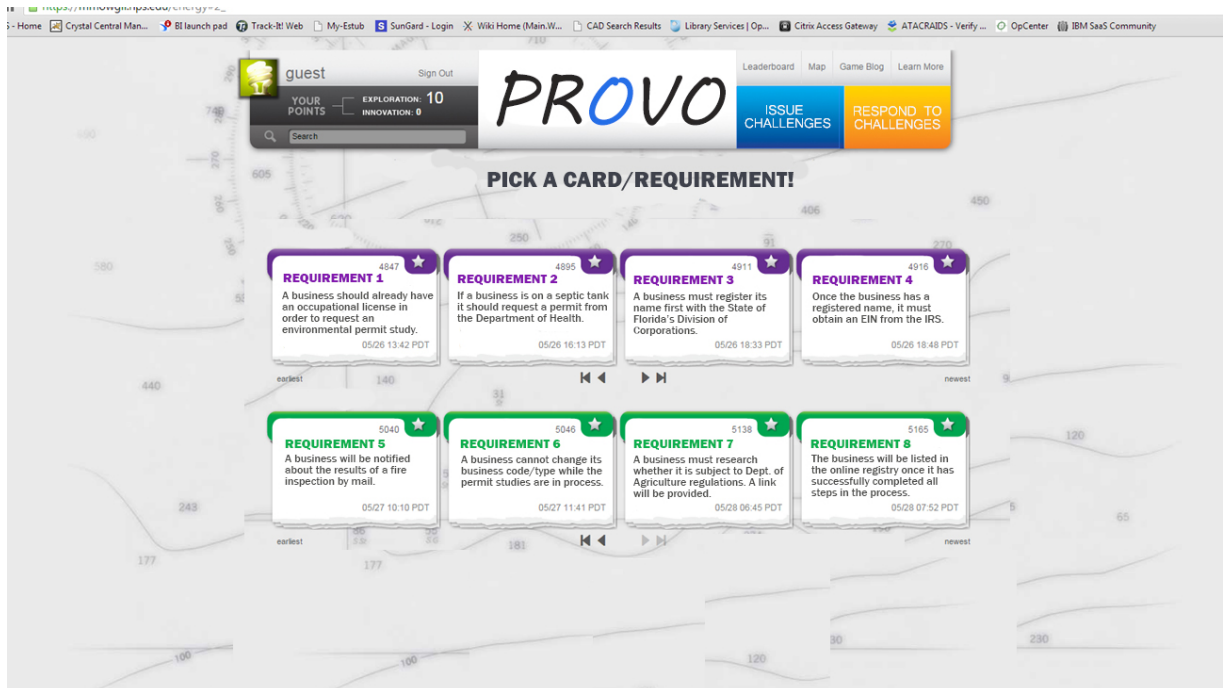
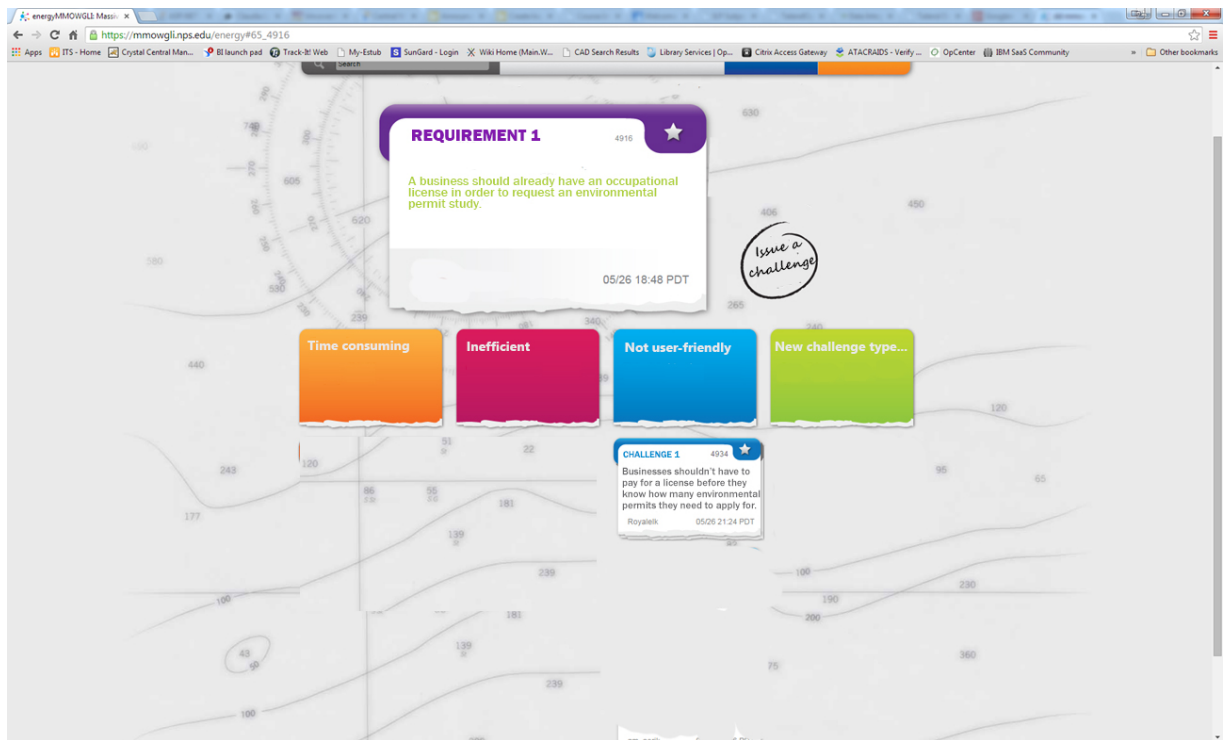
What features should this tool have?

What could make this tool fun?

Appendix C – PROVO Screen Mockups



Team Assignment



Requirement Dashboard

energyMMOWGLL Map - x

https://mmowgli.nps.edu/energy#65_4916

Apps ITS - Home Crystal Central Man... BI launch pad Track-It Web My-Etab SunGard - Login Wiki Home (Main.W... CAD Search Results Library Services | Op... Citrix Access Gateway ATACRAIDS - Verif... OpCenter IBM SaaS Community

REQUIREMENT 1 4916

A business should already have an occupational license in order to request an environmental permit study.

05/26 18:48 PDT

View card chain

Card chain

CARD CONTENT	AUTHOR	CREATED
(4916) A business should already have an occupational license in order to request an...	gm_aerik	05/26 18:48 PDT
(5100) Businesses shouldn't have to pay for a license before they know what environme...	Sass	05/27 22:49 PDT
(4934) A business should obtain an occupational license as the last step in the process...	Royaleik	05/26 21:24 PDT
(4963) Revenue will be lost if businesses are not required to invest in an occup. license	nory	05/27 07:41 PDT
(5007) The fees gathered when obtaining an occ. license could be refundable if the bus...	Royaleik	05/27 09:22 PDT
(5012) Creating a refund option, could furtherburden administrative staff.	nory	05/27 09:27 PDT
(5018) Allow online research of permits by users as a self-service.	Royaleik	05/27 09:33 PDT
(5021) Online research may not be possible because not all GIS services are accessible	nory	05/27 09:37 PDT
(5016) Online permit research using GIS requires certain GIS skills.	Royaleik	05/27 09:31 PDT
(5023) The research should still be available as a self-service because users are more adv...	nory	05/27 09:38 PDT
(4933) Even if research is done by the business itself, it may be erroneous and staff woul...	Royaleik	05/26 21:23 PDT
(4920) Not all businesses should be subject to environmental permit research requirem...	gm_aerik	05/26 19:06 PDT

cancel

maps/mmowgli.nps.edu/energy#65_4916

Home Crystal Central Man... BI launch pad Track-It Web My-Etab SunGard - Login Wiki Home (Main.W... CAD Search Results Library Services | Op... Citrix Access Gateway ATACRAIDS - Verif... OpCenter IBM SaaS Community

guest Sign Out

YOUR POINTS EXPLORATION: 10 INNOVATION: 0

PROVO

ISSUE CHALLENGES RESPOND TO CHALLENGES

CHALLENGE DASHBOARD

CHALLENGES TO TEAM MY CHALLENGES

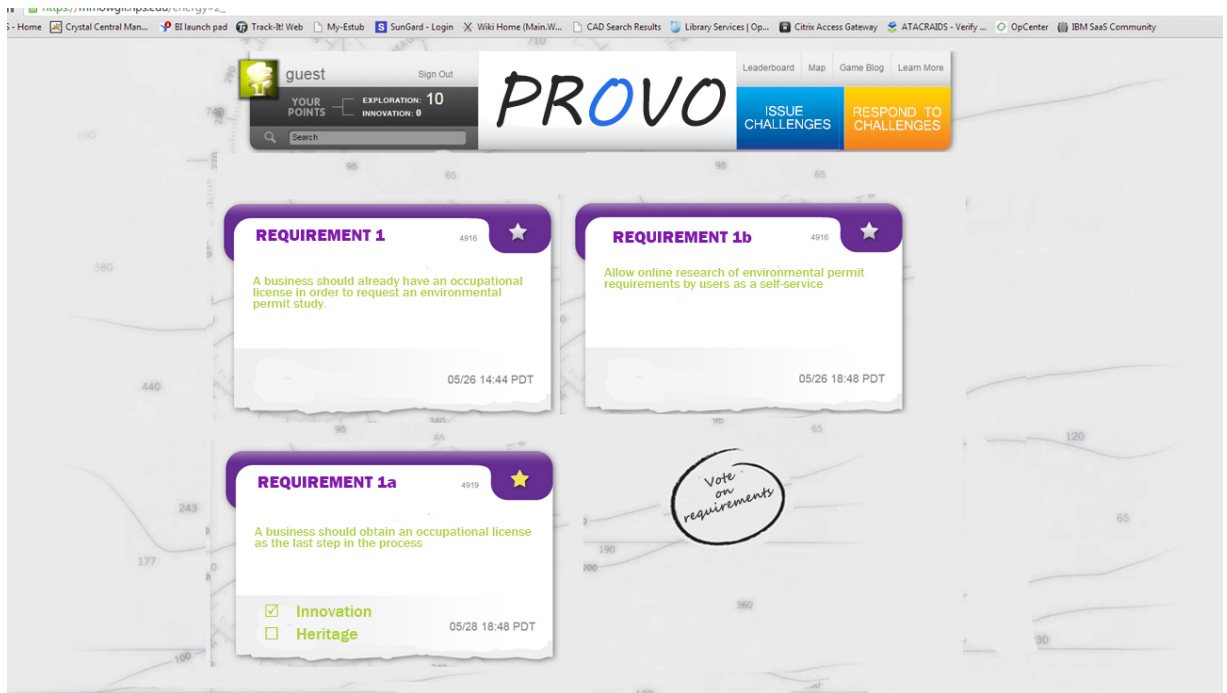
Need Response

Challenges in need of a response

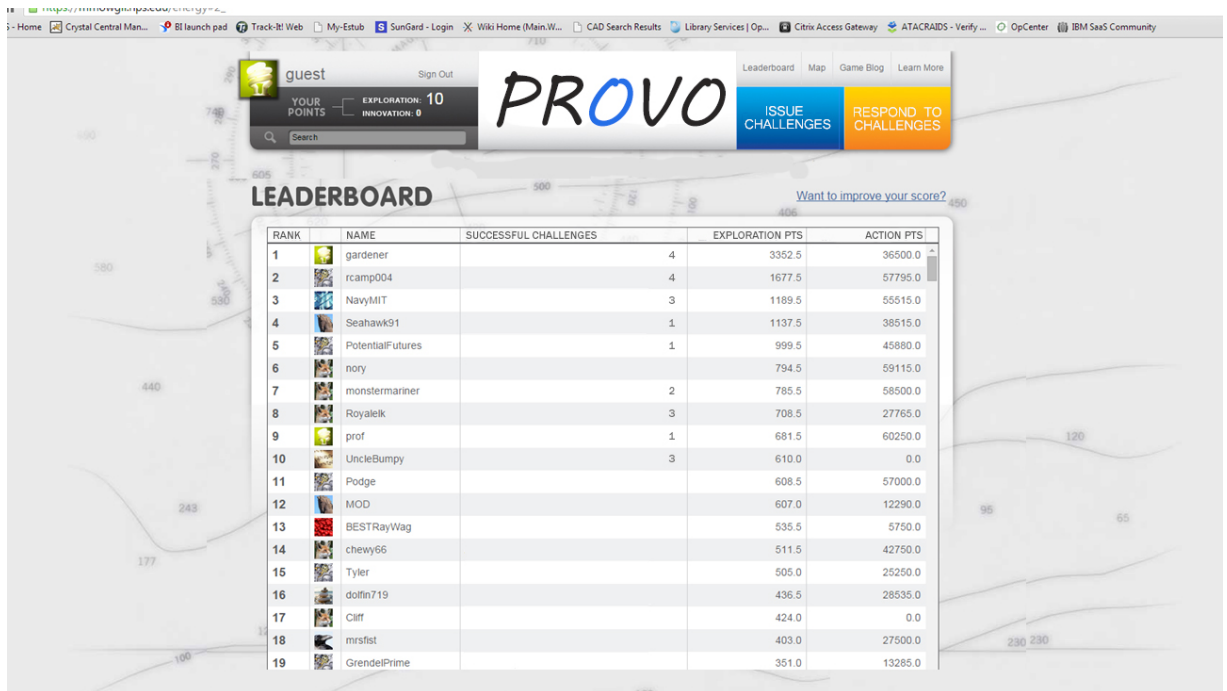
You can morph a requirement in response to a challenge or reject the challenge with a justification

ID	REQ	TITLE	CHALLENGE TYPE
6	1	Businesses shouldn't have to pay ...	Not User-Friendly
9	4	Staff would be overwhelmed by the	Paper-driven process
11	3	Notifications could get lost in mail	Inefficient
20	5	Not all business types should be su...	Not User-Friendly
36	8	Businesses shouldn't show proof ...	Paper-driven process

Challenge Dashboard



Voting



Leaderboard

Appendix D – Risk Analysis Questionnaire

1. People who know me would describe me as a cautious person

- Strongly Agree
- Agree
- No Strong Opinion
- Disagree
- Strongly Disagree

2. I associate the word 'risk' with the idea of 'opportunity'

- Strongly Agree
- Agree
- No Strong Opinion
- Disagree
- Strongly Disagree

3. I (would) feel comfortable about replacing an old (legacy) system with newer technology

- Strongly Agree
- Agree
- No Strong Opinion

- Disagree
- Strongly Disagree

4. I (would) generally look to keep the status quo, and keep old systems in place as long as possible

- Strongly Agree
- Agree
- No Strong Opinion
- Disagree
- Strongly Disagree

5. I am willing to undertake a substantial change to the way my organization functions in order to gain efficiency in the long run

- Strongly Agree
- Agree
- No Strong Opinion
- Disagree
- Strongly Disagree

6. I'd rather minimize changes to the way my organization functions, so stability can be maintained

- Strongly Agree
- Agree
- No Strong Opinion

- Disagree
- Strongly Disagree

Appendix E –JIRA Add-Ons and Customisations

AdaptavistScriptRunner for JIRA: enabled custom scripting for selection of related challenges and morphings

Bob Swift Atlassian Add-ons - Clone Plus: enabled the creation of challenges and morphings with linkages to initial requirements

Bob Swift Atlassian Add-ons - Update on Transition: enabled requirement status updates after challenges and morphs have been issued

Field Security Plugin: Enabled hiding of fields based on user roles

InProduct translation for JIRA: enabled customization of JIRA labels

Issue Rating for JIRA: enabled star ranking of requirements, challenges and morphings

Jiraffe: enabled gamification elements – points, badges and leaderboard

JIRA Misc Workflow Extensions: enabled creation of custom workflow for the morphing cycle

Links Hierarchy: enabled hierarchical display of requirements, challenges and morphings

Slie Jira CustomFields: enabled the addition of new fields for the challenge screens

Structure: enabled the display of requirements in a spreadsheet format

Appendix F - BCL Requirements

Context: A small university library has joined a regional community library consortium. The consortium is transitioning to a new integrated library system, which will be used by all participating libraries, however, these libraries will have the option to customize the software based on their individual requirements.

Below is a list of sample requirements. The staff reviewing them should make no assumptions as to what the company supporting the system can technically do, and they should not be concerned about how much the changes would cost. The company's technical team will be responding to these requirements later. The requirements should be made only with consideration to what is optimal and efficient for library staff and patrons.

Problem: Previous system had a field for email. The presence of an email address in the field indicates a preference to receive notifications by email. The new system instead has a notification preference field. Because that field has not been checked for old records, the patrons are not getting email notifications when their books become available.

Requirement: If there is an email address in the email field default the notification preference to "Email".

Problem: Metadata for the library's collection is not available automatically to the other library sites. In the past the collection was provided to library partners nightly in a large spreadsheet, which the other libraries indexed and added manually to their search.

Requirement: Enable the export of the library's collection via a file, which can be provided to partners in the consortium.

Problem: When printing spine labels and barcodes previously a report was generated in Word, which was then manually adjusted for formatting - for changing the font and size. The new system, allows you to click on a print button, but it generates an Adobe PDF document which does not allow users to change font types and sizes.

Requirement: Enable the export of barcode and label report to Microsoft Word.

Problem: In the patron record of the old system overdue items are listed in a separate tab on the screen, labeled "Overdue Items" and patrons were used to clicking on this tab to see their overdue books and CDs. In the new system, the overdue items are listed along with the any other checked out items, but with the label OVERDUE next to them. Often patrons don't see the label, and miss that information.

Requirement: Add an "Overdue" tab would show overdue items.

Problem: Patrons using the computers in the library, often leave the computers with their search results still on the screen. For privacy purposes, the old search screen, had a clear previous searches button, so the patron could click it after they finish using the computer. The new system does not save the searches, but it does not have a CLEAR button, and patrons think their privacy is at risk.

Requirement: On the public search screen, add a "CLEAR SEARCH" button.

Problem: In the old system, when new materials were introduced, Inter-Library Loan (ILL) holds could not be placed on them for up to 60 days since the items were added to the catalog. The new system does not have that option and new items are automatically available for Inter-Library Loan holds.

Requirement: Automatically disable ability to place ILL holds on new catalog items.

Problem: In the old system multiple phone numbers could be added for a patron. There was the ability to add letter suffixes to the numbers ("c" for cell, "h" for home, "w" for work. For example: 305-444-1000w). In the new system, we have a character limit, and can only add 10 numbers and no letters.

Requirement: Allow additional characters and letters in the phone number field in the patron record.

Problem: In the previous system, when serials were added, there was a field for “Electronic” - E, or “Print” - P. In some cases both could be checked. In the new system electronic serials are a separate type altogether, and the info for a journal, magazine or newspaper needs to be fully re-entered if it is also available electronically.

Requirement: Add a field called Available Electronically” in print serials records.

Problem: When patrons use the discovery service to look up electronic resources from other libraries in the consortium, they cannot easily see the item’s full text availability unless they click to see the full record for the item.

Requirement: Make link to full-text of electronic resources (where permitted) available in the summary record for the item listed in the search results of the discovery service.

Problem: Patrons make ILL requests through a separate system. They have to log in to make the request, but they often forget their login credentials. As a result they call or approach a librarian in person and ask to have the request placed on their behalf. This is time-consuming for library staff. Patrons should be able to request items via ILL as a self-service.

Requirement: Enable patrons to login into the ILL system with the Facebook accounts.

Problem: In the previous system we would start acquisition of an item and leave it “incomplete”, ie no barcode would be added. We would use the item status to signify “in processing”. In the new ILS there are no statuses unless you use the locations in lieu of statuses. Since this is a Dewey library, we would have to add the cutter and call number information in the Technical Services department where our cataloger is. The process in the previous system was that our acquisitions person ordered the item and received it but didn’t actually catalog it.

In addition to this, we would not update our holdings until we actually received the item, but in the new ILS, our business person updates our holdings by virtue of just ordering the item. With the new system, we would have to move the process that our cataloger did to Acquisitions.

Requirement: Add “In Processing” status, and do not automatically update holdings after an item is ordered.